THE MONETARY CIRCUIT APPROACH: A STOCK-FLOW CONSISTENT MODEL*

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INTRODUCTION

In 1999, Marc Lavoie, Professor at the University of Ottawa and author of *Foundations of Post-Keynesian Economic Analysis* (1992), invited Wynne Godley, former Director of the Department of Applied Economics at Cambridge University (1970-1994)[1], to present in Canada's capital what Godley considered to be his most important and radical work to date. Godley had finally managed to represent his macroeconomic theory in a stock-flow consistent accounting framework linking stocks and flows together and integrating money in the best Cambridge post-Keynesian tradition (Godley, 1996, 1999)[2]. For his part, Lavoie was trying to build a post-Keynesian (PK from now on) growth model incorporating money and equities but didn't know exactly how to do it especially for representing choices in the composition of portfolios. He found with Godley's work the method he was missing and Wynne found in him the heterodox economist that would help to make his work more pedagogical, linking it to the rest of post-Keynesian theory.

In 2001, Paul Davidson's *Journal of Post Keynesian Economics* published Lavoie and Godley's first paper in which they present their "model of growth in a coherent monetary framework" (Lavoie and Godley, 2001-2). The interest aroused by this article[3] encouraged them to continue their collaboration and, on top of writing a common book (Lavoie and

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[1] Prior to this, Godley was Deputy Director of the Economics Section at HM Treasury (1956-1970). He is perhaps best known in UK for his role as one of the "six wise men" that provided independent advice to successive Chancellors of the Exchequer between 1992 and 1995.

[2] However most of Godley's ideas had already been presented 16 years ago in Godley and Cripps (1983). Godley's accounting framework was inspired by the works of Tobin and some of his associates at Yale University (Tobin, 1969, 1982; Tobin and Brainard, 1968; Backus, Brainard, Smith and Tobin, 1980)

[3] See for example Taylor (2004) or Dos Santos and Zezza (2004).

Godley, forthcoming), they began presenting their work at conferences. It seems that their work is favorably received in France where economists have always attached a lot of importance to the accounting framework of economic theories.

As a French Canadian and a former student of the University of Paris 1 (Panthéon-Sorbonne), Marc Lavoie is well up on French Economics and especially on the "Circuit theory". In a chapter of the recent book edited by Pierre Piégay and Louis-Phillipe Rochon, which tries to make PK economics accessible to the French public, he claims that the "*matrix method proposed by Godley makes it possible to formalize the circuit theory and to justify the main assertions of the thesis of endogenous money*" (Lavoie, 2003 p. 159).

The aim of this paper is to present the Stock Flow Consistent approach (SFC approach from now on) developed by Lavoie and Godley and to show that, in accordance with Lavoie's assertion, this method makes it possible to model and to understand better the so-called Circuit theory. The first section presents the main principles of the Circuit school and some of the criticisms that are made about this approach: lack of formalism, omission of stocks and basic analysis of the banking system. The second section proposes a model that tries to represent the Circuit theory and to remedy some of its deficiencies. And we use this macroeconomic model in order to study the effectiveness of various policies.

I) A CIRCUIT SCHOOL PRESENTATION AND CRITICISMS.

Basis of monetary circuit of production is directly inspired from the Books 1 and 2 of John Maynard Keynes' *General Theory of Employment money and interest* published in 1936. In this work, considered as the core of the Keynesian Revolution, the author from Cambridge gives money a key role in the economic system regulation. So do the Circuitists. In opposition to the Neoclassics or the Neo Keynesians, they reject the idea of an economy based on exchange, which could be considered as a Keynesian heresy. They analyse economy as a monetary economy of production and thus can be seen as the real heirs of the Keynesian theory.

Today economists and politics pay little attention to Circuitist analysis. This disinterest can be explained by the limitations inherent to Circuitist analysis. According Marc Lavoie (1987), the main limitation of this current, which can explain why it collapsed in the early nineties, is the too strong heterogeneity of Circuitist developments. The Circuitists never managed to agree around fundamental hypothesis and didn't build a real school. Then, even if the Circuitist point of view is very close to John Maynard Keynes' theory, this current failed to gather all Keynesians.

In a first section, we will focus on the shared propositions of the Circuitists. In a second one, we will see the limitations or the unanswered questions of this school.

(1) Circuitist propositions: a monetary economy of production.

As Marc Lavoie (1987) argued, the "Circuitist School" doesn't really exist. The Circuitists or so called writers mainly agree about the importance of money in economy. They never managed to find common fundamental hypotheses, never found a leader and never induced dissidence. Why did we call them "Circuitists" if they didn't manage to agree versus Neo Keynesian School and sometimes didn't consider themselves Circuitists?

As we said, these authors reject the idea of an economy ruled by exchange. In this conception, the only function of money is to allow exchange. Keynes rightly remarked money is not only a "pivot" as the Classics and the Neoclassics think. In his eyes, money has three functions:

- It helps economic actors to exchange
- It is a transaction unit.
- It is a value reserve.

This last function ignored by Classics is perfectly integrated by Keynes in his theory. According to him, money is the link between present and future in the economy. Anyone has the choice to consume his money now or to save it to consume later. The Circuitists emphasised this Keynesian vision of money in their developments. They give money a key role in the economic system. As Alain Parguez showed in his work, if we integrate money in the analysis, we must reject the equilibrium analysis and use a *monetary circuit*. In Circuitists' eyes, the monetary circuit of production isn't a simple tool but a way to consider the economy.

Even if the Circuitists don't represent a proper school, they agree about a number of propositions. We can list two shared ones.

- Endogenous Money and Finance motive.

Endogeneity of money is linked to the production needs. As Rochon and Rossi (2004) said: *"In a monetary economy of production, credit is needed to enable firms to continue and expand production. There is a definitive link between bank credit and economic growth."* Actually, the Circuitists give to credit and therefore to the Finance function in the economy a key role. This function is essential to production. The Circuitists are convinced that finance appears twice in the monetary circuit: before the production process and during the production process (in the circuit).

Before they start producing, according to their anticipations, entrepreneurs need to borrow money from banks. This is what Graziani (1990) call *initial finance*. This step is primordial in Circuitist analysis because it is the first monetary flow that appears in the circuit. It is the monetary creation. In Circuitists' conceptions, money is created to answer entrepreneurs' anticipations.

During the production process entrepreneurs recover part of the income generated by production (investment, consumption, saving) during the production process. This is the *final finance* (Graziani, 1990). At this stage, entrepreneurs can pay back their loans.

The endogeneous character of money appears at the first step of the circuit. Actually money creation doesn't depend on a money supply function but on firms' needs and entrepreneurs' anticipations to begin their activities.

Using a monetary circuit involves - as we can see - a hierarchy between macroeconomic agents and so a temporal perspective. Its first movement is monetary creation and all activities are linked to this creation. Step by step, after monetary creation, economic activity appears in the circuit and makes it possible relationships between macroeconomic agents. This idea is shared by all the Circuitists and probably represents the originality of their developments.

- Macroeconomic laws.

Frédéric Poulon (1982) argues that microeconomic method integrating money in analyses is wrong. In his view, we can't consider money in the economy in the light of a *money supply function*. This method would be right if money was – as the Classics think – a simple good which enables exchange. But as we noticed, this analysis is wrong: money has value reserve function which can only be considered in a macroeconomic view. Money is macroeconomic phenomenon so the integration of money in analysis can not be done with a microeconomic method but with a macroeconomic one. According to the Circuitists the correct macroeconomic method to integrate money in economy is to consider *money creation*.

The consequences of using this method are important because Circuitist analyses show that the structural relationships that exist between macroeconomic agents are totally independent from rational microeconomic behaviours. The most important one is the reversal

of the traditional causality between saving and investment. In a microeconomic point of view, investment is dependent of saving. Frédéric Poulon (2000) underlined this causality vanished when we use a macroeconomic method. This macroeconomic law supposed to be the core of the Keynesian Revolution can be perfectly understood using the monetary circuit of production.

(2) Limitations of Circuitist developments.

Basically we can point out three limitations: lack of formalism, omission of stocks and basic analysis of the banking system.

- Lack of formalism.

One problem of Circuitist developments is that there is almost no formalization of the monetary circuit approach. In the second section of this paper we propose a model that tries to represent the Circuit theory on the basis of the framework proposed by Frederic Poulon (1982). Using Books 1&2 of the *General Theory of Employment, interest and money,* Poulon reduces the economy to three basic functions: Finance, Production and Consumption. The economy is regulated by these three functions and relationships between them are monetary flows.

<u>Functions:</u>

B: Finance.

Fm: Production.

Hs: Consumption.

<u>Flows:</u>

ΔF: Initial Finance.

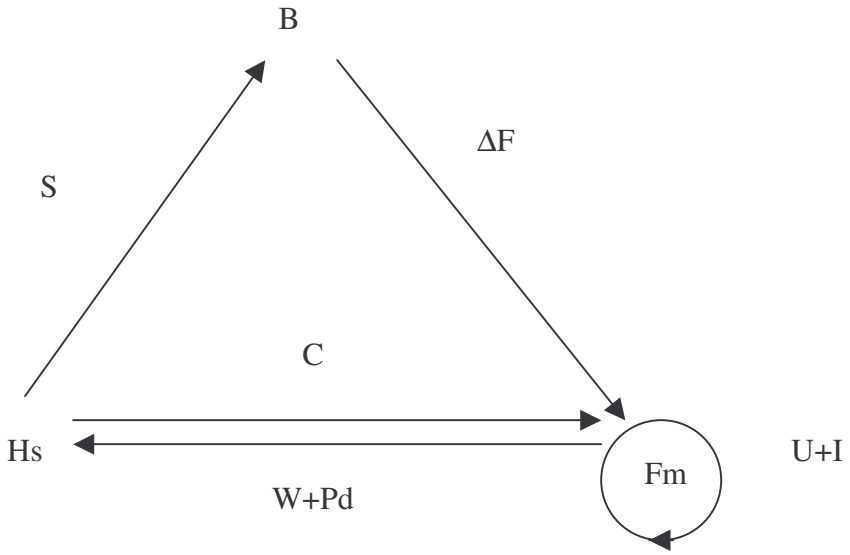
U: User Cost.

I: Firms Net Investment

Y: Household Income. We suppose household income is composed by wages and shared Profit. $Y = W + Pd$

C: Household consumption.

S: Household saving.



Graphic 1 : ***POULON Framework***

Along this circuit we can follow a representative monetary unit. This unit is created by banks (**ΔF**), according to the monetary circuit theory. Once in the production pole this unit is split in two. A first monetary flow is oriented to firms themselves. Actually to produce firms need to invest in equipment goods (**I**), raw material (**CI**) and in maintenance of their own equipment (**CCF**). Frederic Poulon supposes these last two costs represent the Keynesian *User Cost* (**U**) described in chapter 6 of the *General Theory of Employment, Interest and Money*. The second monetary flow goes to the Consumption pole. As described in this circuit, only Households consume and they get their income from firms. As we said we suppose households' income is composed by wages (**W**) and Shared firm's profit (**Pd**). Households consume a part of it (**C**) and save the other. As we can see the circuit is closed with this last monetary flow.

Frederic Poulon's framework expresses rigorously the two circuitists shared propositions. However, this model is not accepted by all the Circuitists: some of them fell that this framework is already an extrapolation of Keynesian theory.

- Basic analysis of the banking system

A problem of the framework proposed by Frederic Poulon is that it practically ignores the role of the Central Bank. This is typical of Circuitist analysis. In fact the central bank is represented in the Finance Pole (Pole B in the previous circuit) but this is not very explicit. In his book written with Jean Marchal (1987), Frederic Poulon has proposed a more complex framework that tries to explain the links between the deposit banks (DB) and the Central Bank (CB).

New Flows induced by the central bank presence:

ΔA: Central Bank advances

ΔH_b: DB Reserves placed at the Central Bank

ΔH_h: Households' cash holdings in circulation

ΔD: Households' bank deposits.

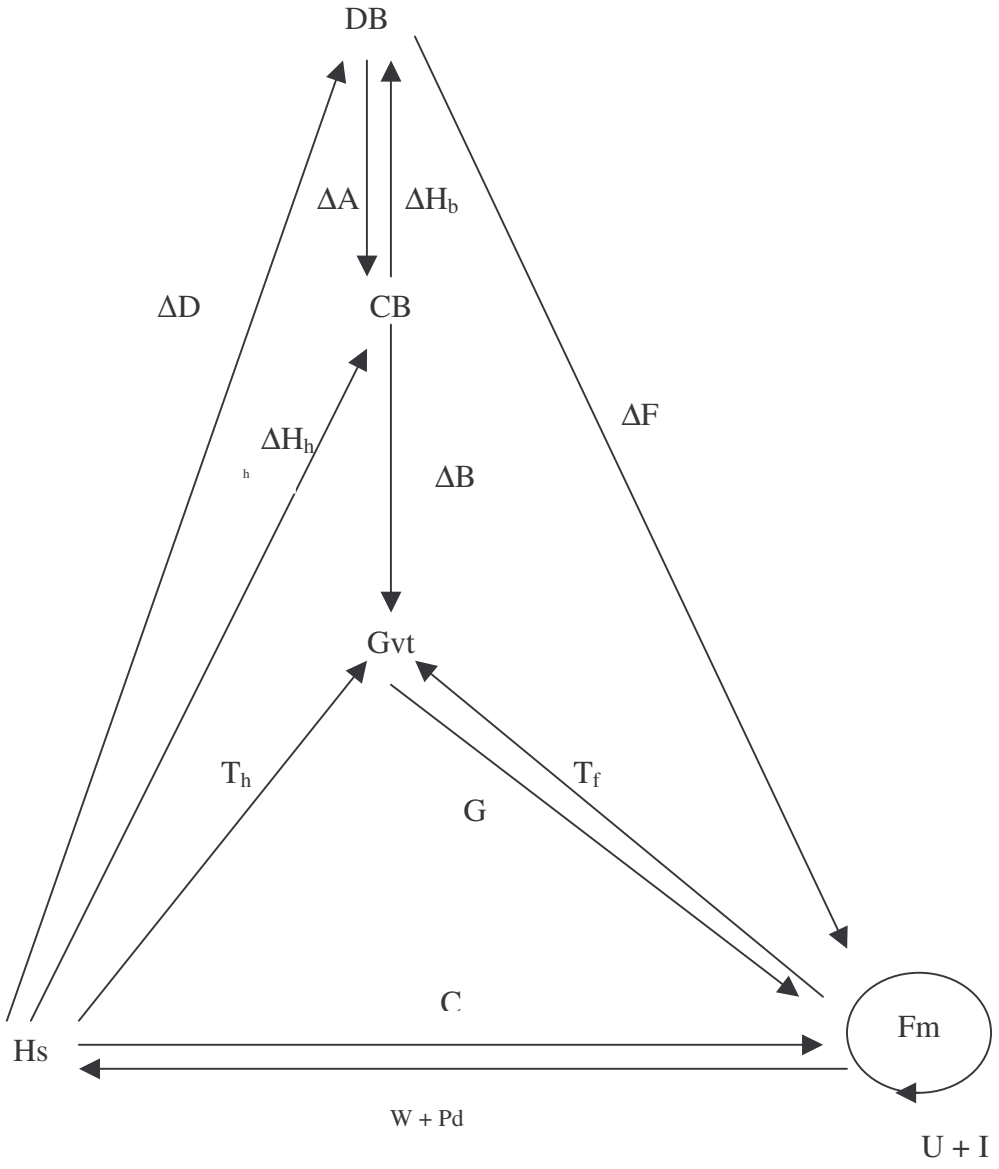
In this new circuit Poulon considers the government function (Gvt)

New Flows:

G: Public expenditures.

T: taxes paid both by firms (T_f) and households (T_h).

ΔB: Public deficit financed by Treasury bills .



Graphic 2 : Circuit with central bank

In the second section we use this framework linking the Circuit theory to the post-Keynesian analysis of endogenous money in banking systems (the so-called *Horizontalist* approach). However, we can note that another way to introduce a Central Bank in the Circuit theory has been proposed by Rochon and Rossi (2004). Rochon and Rossi note that the existence of multiple banks raises the possibility that a bank may be indebted to another one as a result of the great number of incoming/outgoing payments initiated by the non-bank sector. They also showed that "*inflows or outflows implied by the monetary transactions require that the banking system be complemented by a settlement institution that provides lender-of-last-resort facilities for the bilateral debt-credit relationships born in the interbank market to be settled*".

Rochon and Rossi built a circuit which emphasises relationships between two banks and a central bank. They admit that if the two banks were one and the same bank, the result of the transaction between their respective clients (who have the transaction) would be simpler and correspond to the case *traditionally considered by the theory of the monetary circuit* (described in the previous circuit).

Their contribution is very interesting because it helps Circuit Theory to fill an important void (they give to the Central bank a key role in the Economy). They underline that the central bank isn't only a lender of last resort acting in times of crisis which is a real progress in a circuitist analysis. They show its involvement is *"at the heart of the stability of the financial system on a daily basis*.

- Omission of stocks.

In circuitist writers' views hoarding is considered as a part of the saving flow. Actually they consider the *liquidity preference* as a propensity applied to the saving flow. Franck Van De Velde (2005) argued that this point of view is wrong. According to him the *liquidity preference* is a function which links interest rate to stocks of money people want to hold.

The last remark sheds lights on the more important limitation of the monetary circuit analyses: the absence of stocks. As we know the monetary circuit is only composed of flows, stocks are never taken into account. So a part of the information relating to preference to liquidity is missing. The Circuit theory fails to present properly the Keynesian interest rate theory.

The model proposed in the next section tries to incorporate stocks in a circuit analysis framework and fill that void.

II THE S.F.C. MODEL

Building a SFC model requires 3 steps: writing the matrixes, counting the variables and the accounting identities issued from the matrixes, defining each unknown with an equation (accounting identity or behavioural equation).

(1) Matrixes

We discuss here a closed economy without inflation that is essentially the same as the one proposed by Lavoie and Godley (2001-2). Firms issue equities and borrow money from banks to finance investment but they neither hold money balance nor issue bonds. They have excess capacity but no inventories[4]. Firms use two factors for producing goods (fixed capital and labour) but we deal with a vertically-integrated sector and hence ignore all intermediate goods[5]. Banks have no operating costs and they don't make loans to households. Banks have zero net worth but contrary to Lavoie and Godley, the rate of interest on money deposit is different from the rate of interest on loans: we just postulate that any profits realized by private banks are immediately transferred to households.

The main improvement to Lavoie and Godley's growth model is the introduction of a government and a central bank[6]. In the same way as private banks, the central bank has neither operating costs nor net worth (the central bank pays back all its profits to the government). The government collects taxes from firms and households (but not from private banks) and finances its deficit by issuing Treasury bills. Government expenditures are only final sales of consumption goods: there is neither operating costs (like wages for state employees) nor transfers between households.

Godley's accounting method is based on two tables: a balance sheet matrix and a transactions matrix. Table 1 gives the transactions matrix that describes monetary flows between the five sectors of the economy. Every row represents a monetary transaction and every column corresponds to a sector account which is fragmented, except in the basic case of the government, in a current and a capital account. Sources of funds appear with plus signs and uses of funds with negative signs so every row must sum to zero seeing that each transaction corresponds always simultaneously to a source and a use of funds. The sum of each column must also be zero since each account (or sub-account) is balanced.

[4] Excess capacity exists because of expectations of future demand, entry barriers, cost minimization, time-taking production… For the role of inventories see Lavoie and Godley (forthcoming: chapter 9).

[5] This assumption sets aside all the production and pricing interdependencies between goods that are to be found in a Leontieff input-output model or in the Sraffian model.

[6] This work is also inspired by the model realized by Claudio Dos Santos and Gennaro Zezza (2004)

Secteur / Opération	Govt	Firms		Households		Private banks		Central Bank		Σ
		Current	Capital	Current	Capital	Current	Capital	Current	Capital	
Consumption		+ C		- C						0
Govt expenditures	- G	+ G								0
Net investment		+ I	- I							0
Wages		- W		+ W						0
Taxes	+ T	- T_f		- T_h						0
Interest on T. Bills	- $r_{b\,-1}.B_{-1}$			+ $r_{b\,-1}.B_{h\,-1}$		+ $r_{b\,-1}.\ B_{b\,-1}$		+ $r_{b\,-1}.B_{cb\,-1}$		0
Interest on bank deposits				+ $r_{d\,-1}.D_{-1}$		- $r_{d-1}.D_{-1}$				0
Interest on loans		- $r_{l\,-1}\,.L_{\,-1}$				+ $r_{l\,-1}\,.L_{\,-1}$				0
Interest on CB advances						- $r_{a\,-1}\,.A_{-1}$		+ $r_{a\,-1}\,.A_{-1}$		0
Profits of firms		- P	+ P^u	+ P^d						0
Profits of banks				+ P_b		- P_b				0
Profits of CB	+ P_{bc}							- P_{cb}		0
Hous. savings				- S	+ S					0
Δ HPM					- ΔH_h		- ΔH_b		+ ΔH	0
Δ T Bills	+ ΔB				-ΔB_h		- ΔB_b		- ΔB_{cb}	0
Δ equities			+ $\Delta e\ .\ p_e$		- $\Delta e\ .\ p_e$					0
Δ bank deposits					- ΔD		+ ΔD			0
Δ loans			+ ΔL				- ΔL			0
Δ CB advances							+ ΔA		- ΔA	0
Σ	0	0	0	0	0	0	0	0	0	0

Table 1: Transactions matrix

Table 2 gives the balance sheet matrix of our postulated economy. Symbols with plus describe assets and negative signs indicate liabilities. The sum of every row is again zero except in the case of accumulated capital in the industrial sector. The last row presents the net wealth of each sector and permits each column to sum to zero.

Sector / Assets	Government	Firms	Households	Private banks	Central Bank	Σ
Capital		+ K				+ K
HPM			+ H_h	+ H_b	- H	0
T. Bills	- B		+B_h	+ B_b	+ B_{cb}	0
Equities		- e · p_e	+ e · p_e			0
Bank deposits			+ D	- D		0
Loans		- L		+ L		0
CB advances				- A	+ A	0
Net wealth	+ B	- V_f	- V_h	0	0	- K
Σ	0	0	0	0	0	0

Table 2: Balance sheet matrix

(2) Variables and accounting identities

Building a model that describes the monetary circuit discussed above in a consistent way requires to be sure that the transactions matrix should be properly translated into equations. First, the model must contain the 29 variables of the matrix[7]. Each of these 29 variables can be associated with the behaviour of one of the 5 sectors of our economy.

Government: G, T, T_h, T_f, B

Firms: I, W, P, P^u, P^d, e

Households: C, S, H_h, D, B_h, p_e

Private banks: H_b, r_l, L, B_b, r_d, P_b

Central Bank: H, r_a, A, r_b, B_{cb}, P_{cb}

Second, we must use the accounting identities resulting from the fact that each row and each column sum to zero. Here we have thirteen accounting identities corresponding to the nine columns and to the four non-ordinary rows[8]. For a start we just transcribe the identities (uses of funds on the left side, sources of funds on the right side) without précising how we will use them in the model:

(i) $r_{b-1} \cdot B_{-1} + G \equiv T + P_{cb} + \Delta B$

(ii) $W + T_f + r_{l-1} \cdot L_{-1} + P \equiv C + I + G$

(iii) $I \equiv P^u + \Delta e \cdot p_e + \Delta L$

(iv) $C + T_h + S \equiv W + r_{b-1} \cdot B_{h-1} + r_{d-1} \cdot D_{-1} + P^d + P_b$

(v) $\Delta H_h + \Delta B_h + \Delta e \cdot p_e + \Delta D \equiv S$

[7] The meaning of most of the symbols is made explicit in the left column of the matrix.

[8] What we call *non-ordinar*y row is a row that includes at least two different variables.

(vi) $P_b + r_{d-1} \cdot D_{-1} + r_{a-1} \cdot A_{-1} \equiv r_{b-1} \cdot B_{b-1} + r_{l-1} \cdot L_{-1}$

(vii) $\Delta H_b + \Delta B_b + \Delta L \equiv \Delta D + \Delta A$

(viii) $P_{cb} \equiv r_{b-1} \cdot B_{cb-1} + r_{a-1} \cdot A_{-1}$

(ix) $\Delta A + \Delta B_{cb} \equiv \Delta H$

(x) $T_h + T_f \equiv T$

(xi) $P \equiv P^u + P^d$

(xii) $\Delta H_h + \Delta H_b \equiv \Delta H$

(xiii) $\Delta B_h + \Delta B_b + \Delta B_{cb} \equiv \Delta B$

A feature of SFC models is that if there are M columns and N non ordinary rows in the transactions matrix, then there are only (M + N – 1) independent accounting identities in the model. Due to this principle, highly similar to Walras' Law, one equation must be kept out: we shall use exactly twelve accounting identities in the model.

Concerning the balance sheet matrix things are simpler. There is no need to use (M + N – 1) equations: we just make sure that initial values of stocks are consistent with the matrix[9]. In the following periods, stocks will stay consistent since our twelve identities will generate consistent flows. In our model we use only one identity issued from the balance sheet matrix:

(xiv) $V_h \equiv H_h + e \cdot p_e + D + B_h$

(3) Equations

Now we must define every variable relative to the five sectors of the economy using an accounting identity or a behavioural equation. When we use an accounting identity we often need to rewrite it so we will always recall its number (using Roman numeral) in order to enable the reader to recognize it easily. More important, when we introduce new unknowns in a behavioural equation we define them immediately so that our model should have the same number of equations as unknowns.

- Government: G, T, T_h, T_f, B

We assume that public expenditures *G* are growing at the same rate gr_y as the national income *Y*:

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

(2) $gr_y = \Delta Y / Y_{-1}$

(3) $Y = C + I + G$

When we solve the model using a computer this assumption makes it easier to find a steady state although we think that it would have been better to model the growth rate of public expenditure as an exogenous parameter.

In this model, the government collects taxes from firms T_f and households T_h:

(4-x) $T \equiv T_h + T_f$

[9] Initial values of stocks can be found in the appendix.

where taxes on firms are composed of indirect taxes on sales Y[10] and direct taxes on profits:

(5) $T_f = T_y + T_p$

(6) $T_y = \tau_1 \cdot Y$

(7) $T_p = \tau_2 \cdot P_{-1}$

and households pay direct taxes on wages and wealth:

(8) $T_h = T_w + T_v$

(9) $T_w = \tau_3 \cdot W_{-1}$

(10) $T_v = \tau_4 \cdot V_{h\,-1}$ with τ_i : constants

The government finances any deficit issuing bills, so that the supply of bills 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:

(11-i) $B \equiv B_{-1} + DG$

(12) $DG = G + r_{b\,-1} \cdot B_{-1} - T - P_{cb}$

- Firms: I, W, P, P^u, P^d, e

The investment function is the most important one in a growth model. In their paper Lavoie and Godley (2001-2) use the PK investment function tested empirically by Ndikumana (1999). In the Ndikumana model there are four variables that explain the rate of accumulation gr_k : the ratio of cash flow to capital r_{cf} , the ratio of interest payments to capital $(r_l \cdot L)/K$, Tobin's q ratio and the rate of growth of sales. They use the first three of these and replace the fourth by the rate of capacity utilization, which is a feature of Kaleckian growth models:

(13) $I = gr_k \cdot K_{-1}$

(14) $K = K_{-1} + I$

(15a) $gr_k = \gamma_0 + \gamma_1 .r_{cf\,-1} - \gamma_2 .r_{l\,-1} .l_{-1} + \gamma_3 .q_{-1} + \gamma_4 .u_{-1}$ with γ_i : constants

In order to make this function compatible with the Circuit theory we have decided to suppress the constant γ_0 and Tobin's q and to replace the rate of cash flow r_{cf} by its expected value r_{cf}^a. Therefore equation (15a) is replaced by equation (15):

(15) $gr_k = \gamma_1 .r_{cf}^{\,a} - \gamma_2 .r_{l\,-1} .l_{-1} + \gamma_3 .u_{-1}$ with γ_i : constants

According to the PK theory, it is the *expected* rate of cash flow r_{cf}^a that enters in the investment decision. As it is impossible to measure empirically these expectations, Ndikumana's function only contains the rate of cash flow of the previous period while the residue obtained γ_0 is understood as the "animal spirits" of the entrepreneurs including expectations. However there is no place for such a residue in a theoretical model. We must have an investment function that contains *explicitly* the expectations although we know that the question of their modelling has still not been answered satisfactorily. Even if it does not make the slightest difference with Lavoie and Godley's formulation it is better to introduce an expected rate of cash flow defined by a basic mechanism. In this model, the expected value

[10] In this closed economy, sales are equal to the national income.

of any variable for current period (represented with the superscript *a*) depends on its value of the previous period plus an error correction mechanism where θ represents the speed of adjustment in expectations[11]:

(16) $r_{cf}^{a} = r_{cf-1} + \theta_f \cdot (r_{cf-1} - r_{cf}^{a}{}_{-1})$ with θ_f : constant

where the rate of cash flow is the ratio of retained earnings to capital:

(17) $r_{cf} = P^u / K_{-1}$

As for Tobin's q ratio it would be hard to justify its utilization from a circuitist point of view. Lavoie and Godley themselves recognize that "*Tobin's q ratio is not usually incorporated into heterodox growth models with financial variables.* (…) *Kaldor himself* [however inventor before Tobin of the "valuation ratio"] *did not believe that such a ratio would have much effect on investment*" (Lavoie and Godley, 2001-2: pp. 286-287). Due to the presence of Tobin's q, Lavoie and Godley's model could generate non-intuitive results in what they call a *puzzling* regime.

On the other hand we have retained the negative impact of interest payments on investment and Lavoie and Godley's change concerning the replacement of the growth rate of sales by the utilization rate.

The negative impact of firms' interest payments on investment reflects credit constraints by banks that appear at the beginning of the monetary circuit. "*Credit constraints thus appear at the stage of* ***initial*** *finance* [as in equation (16)], *not at the stage of* ***final*** *finance* [as in equation (48)] (Lavoie, 2001, p.14). In equation (16) the leverage ratio *l* is the debt-to-capital ratio of the firms:

(18) $l = L / K$

Concerning the adoption of Lavoie and Godley's change in our model, it can seem strange considering that the Circuitists make mention of the impact of the growth rate on investment (through the traditional *accelerator* effect) but never analyse the impact of the utilization rate. However this change is the consequence of reintroducing stocks in the analysis. As they don't pay attention to the stock of capital, the Circuitists don't use any rate of utilization capacity. Contrary to that, in a Kaleckian model an increase in the global demand will generate an increase of production and of the utilization rate. This rise leads the entrepreneurs to accelerate their accumulation. Thus, any rise in the effective demand will induce an increase in the growth rate of the economy. This is a variant of the traditional *accelerator* effect. The rate of capacity utilization is defined as the ratio of output to full capacity output Y_{fc}

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

where the capital-to-full capacity ratio σ is defined as a constant:

(20) $Y_{fc} = K_{-1} / \sigma$ with σ: constant

Concerning wages, they can be decomposed into a unit wage *w* times the level of employment *N*:

(a) $W = w \cdot N$

where employment is determined by sales given productivity μ[12]:

[11] Note that with this expectation mechanism, if the variable to be forecasted is stationary, its expected value will always be correct on average.

(b) $N = Y / \mu$ with μ: constant

Following Lavoie and Godley it is assumed, as it is usual in PK models, that prices are set as a mark up ρ on unit direct cost *UDC*:

(c) $p = (1 + \rho) \cdot UDC$ with ρ: constant

where unit direct cost is the ratio of direct costs (that consist entirely of wages) on net sales (gross sales minus indirect taxes on sales):

(d) $UDC = W / (Y - T_y)$

Under these assumptions we have:

(e) $p = (1 + \rho) \cdot w / (\mu \cdot (1- \tau_1))$

In this model there is no inflation and prices are set exogenously to 1 so equation (e) can be rewritten:

(e') $w = \mu \cdot (1 - \tau_1) / (1 + \rho)$

Finally, equations (a), (b) and (e') can be condensed in equation (21) that determines wages:

(21) $W = Y \cdot (1 - \tau_1) / (1 + \rho)$ with ρ: constant

Total profits P of firms are the difference between their sales and their expenditures (wages, taxes and interest payments) :

(22-ii) $P \equiv C + I + G - W - T_f - r_{l-1} \cdot L_{-1}$

Distributed dividends P^d are a fraction of profits realized in the previous period:

(23) $P^d = (1 - s_f). P_{-1}$ with s_f : constant

and retained earnings P^u are determined as the residue:

(24-xi) $P^u \equiv P - P^d$

Equations concerning issues of equities by firms are usually oversimplified in SFC models. Lavoie and Godley (2002-2) and Taylor (2004) assume that firms finance a percentage *x* of their investment expenditures with equities, regardless of the price of equities or of the value taken by usual valuation ratios. With a lag their function is:

$\Delta e \cdot p_e = x \cdot I_{-1}$

$\Leftrightarrow$ (25) $e = e_{-1} + x \cdot I_{-1} / p_e$ with x : constant

In a similar perspective, Dos Santos and Zezza (2005) postulate that firms keep a fixed amount of equities-to-capital ratio χ[13]:

$e . p_e = \chi \cdot K$ with χ: constant

with flows: (25') $\Delta e \cdot p_e + \Delta p_e \cdot e_{-1} = \chi \cdot I$

As for Kim (2005), he assumes that the stock of shares grows at a constant rate gr_e:

$\Delta e / e_{-1} = gr_e$

(25'') $e = e_{-1} \cdot (1+gr_e)$ with gr_e: constant

[12] Here we assume implicitly that there is no overhead or fixed labour. However additional outlays on unproductive labour could have a significant impact on the economic activity.

[13] This is the hypothesis implicitly made by the Circuitist Poulon in his analysis of crisis.

Alternative formulations would have been possible[14] but for this model we have chosen to retain equation (25) (but the functioning of the model is exactly the same in the case of equation (25') or (25'')).

- Households: C, S, H_h, D, B_h, p_e

We assume that households determine their consumption expenditure C on the basis of their expected disposable income and their expected wealth V_h^a :

(26) $C = \alpha_1 . Y_w^a + \alpha_2 \cdot Y_v^a + \alpha_3 . V_h^a$ with α_i : constants $1>\alpha_1>\alpha_2>\alpha_3>0$

(27) $Y_w = W - T_w$

(28) $Y_w^a = Y_{w-1} + \theta_h \cdot (Y_{w-1} - Y_{w-1}^a)$ with θ_h : constant

(29) $Y_v = r_{d-1} \cdot D_{-1} + r_{b-1} \cdot B_{h-1} + P^d + P_b - T_v$

(30) $Y_v^a = Y_{v-1} + \theta_h \cdot (Y_{v-1} - Y_{v-1}^a)$

where Y_w^a is the expected disposable income of workers, Y_v^a the expected disposable financial income and each α_i is a propensity to consume. We assume, following the Kaleckian tradition, that wages are mostly consumed while financial income is largely devoted to saving ($1>\alpha_1>\alpha_2>0$). This class-based saving behaviour is not without consequences in a SFC model where interest payments play a great role. In their model, which has many things in common with our, Dos Santos and Zezza don't consider it[15]. That's probably the reason why they find, contrary to us, that an increase of the entire structure of interest rates is moving the economy to a higher growth path in the long run (Dos Santos and Zezza, 2004: pp. 203-204).

This consumption decision determines the amount that households will save out of their disposable income Y_h:

(31-iv) $S \equiv Y_h - C$

(32) $Y_h = Y_w + Y_v$

The change in total households' wealth ΔV_h is equal to these savings plus the capital gains of the period:

(33-v) $V_h \equiv V_{h-1} + S + CG$

where CG are capital gains arising from the fluctuations in the price of equities[16]:

(34) $CG = \Delta p_e . e_{-1}$

In the same way, the expected wealth of households V_h^a is a function of their *expected* disposable income Y_h^a and of their *expected* capital gains V_h^a:

---

[14] For example we know that actually pension funds require high levels of rate of return from firms (from 10% to 15%). So we could have assumed that firms control their stock of shares in order to satisfy a required rate of return r_r (= $P^d / e \cdot p_e$):

$e = P^d / r_r \cdot p_e$ with r_r : constant

This can explain why some American firms are now buying back their shares.

[15] They follow Lavoie and Godley (2001-2) that don't make this distinction either even if they present their model as a kaleckian one.

[16] As capital gains do not appear in the transactions matrix, it is important to remember that any change in the value of an asset may be made up of two components: a component associated with a transaction involving additional units of the asset in question and a component with a change in the price of the asset. In our model shares are the only assets of households' portfolio whose price can change. The change in the value of equities arising from the transactions is $\Delta e \cdot p_e$ while the change in the value of equities arising from capital gains is $\Delta p_e . e_{-1}$. The global change in the value of equities is $\Delta(e \cdot p_e) = \Delta e \cdot p_e + \Delta p_e \cdot e_{-1}$

(35) $V_h^a = V_{h-1} + Y_h^a - C + CG^a$

(36) $Y_h^a = Y_{h-1} + \theta_h \cdot (Y_{h-1} - Y_h^a{}_{-1})$

(37) $CG^a = CG_{-1} + \theta_h \cdot (CG_{-1} - CG^a{}_{-1})$

We assume that households' holdings of cash money are a fixed share of their consumption:

(38) $H_h = \eta_h \cdot C$ with η_h : constant

In this model the central bank provide all the cash money demanded by households.

We now come to the equations defining the portfolio behaviour of households. We follow the methodology developed by Lavoie and Godley and inspired by Tobin (1969).On top of cash money, households can hold three different assets: treasury bills B_h, equities $E=e.p_e$ and bank deposits D. We first present portfolio behaviour in the form of matrix algebra:

$$\begin{vmatrix} B_h \\ E \\ D \end{vmatrix} = \begin{vmatrix} \lambda_{10} \\ \lambda_{20} \\ \lambda_{30} \end{vmatrix} * (V_h^a - H_h) + \begin{vmatrix} \lambda_{11} & \lambda_{12} & \lambda_{13} \\ \lambda_{21} & \lambda_{22} & \lambda_{23} \\ \lambda_{31} & \lambda_{32} & \lambda_{33} \end{vmatrix} * \begin{vmatrix} r_b \\ r_e^a \\ r_d \end{vmatrix} * (V_h^a - H_h)$$

The λ_{ij} parameters follow the vertical, horizontal and symmetry constraints (Lavoie and Godley, forthcoming). Households are assumed to hold a certain proportion λ_{i0} of their expected wealth V_h^a (net of cash holdings H_h) in the form of asset *i* but this proportion is modified by the rates of return on these assets. Households are concerned about r_b and r_d, the rates of interest on Treasury bills and on bank deposits to be determined at the end of the current period, but which will generate the interest payments in the following period. We have further assumed that it is the expected rate of return on equities r_e^a that enters into the determination of portfolio choice:

(39) $r_e^a = (P^{d\,a} + CG^a) / (p_{e-1} \cdot e_{-1})$

(40) $P^{d\,a} = P^{d\,a}{}_{-1} + \theta_h \cdot (P^d{}_{-1} - P^{da}{}_{-1})$

The three assets demand function described with the matrix algebra are thus:

(41) $B_h = (\lambda_{10} + \lambda_{11} \cdot r_b - \lambda_{12} \cdot r_e^a - \lambda_{13} \cdot r_d) \cdot (V_h^a - H_h)$ with λ_{ij}: constants

(42) $E = (\lambda_{20} - \lambda_{21} \cdot r_b + \lambda_{22} \cdot r_e^a - \lambda_{23} \cdot r_d) \cdot (V_h^a - H_h)$

(43a) $D = (\lambda_{20} - \lambda_{21} \cdot r_b - \lambda_{22} \cdot r_e^a + \lambda_{23} \cdot r_d) \cdot (V_h^a - H_h)$

As it is the case with every matrix, we cannot keep all these equations in the model because each one of them is a logical implication of the others. We have decided to model bank deposits as the residual equation because when there is imperfect foresight, the amount of deposits held will be the residual. So equation (43a) has been dropped and replaced by (43):

(43-xiv) $D \equiv V_h - H_h - B_h - E$

The only price clearing mechanism of this model occurs in the equity market. The price of equities will allow the equilibrium between the *number* of shares *e* that has been

issued by firms (the supply) and the *amount* of shares *E* that households want to hold (the demand):

(44) $p_e = E / e$

- Banking system: H_b, H, r_l, L, r_a, A, r_b, B_b, B_{cb}, r_d, Pb, P_{cb}

It is assumed that banks are obliged by the government to hold reserves H_b that do not generate interest payments and that must always be a fixed share (the compulsory ratio η_b) of deposits:

(45) $H_b = \eta_b \cdot D$ with η_b: constant

The bank reserves together with cash in the hands of households H_h make up what is called *base money* or *high powered money* H:

(46-xii) $H \equiv H_h + H_b$

Following the theory of endogenous money (the so-called *horizontalist* view) we assume that private banks are fully *accommodating*. They (i) fix a rate of interest on loans r_l applying a mark-up m_1 on the key rate of the central bank r_a[17] and then (ii) provide whatever loans *L* demanded by *credit-worthy* firms at this rate:

(47) $r_l = r_a + m_1$ with m_1: constant

(48-iii) $L \equiv L_{-1} + I - P^u - \Delta e \cdot p_e$

Credit-worthy firms are firms that can provide financial guarantees that they will be able to honour their orders. In this model, credit constraints imposed by banks at the stage of initial finance (as analyzed in the circuit theory) are incorporated within the investment function with the later being sensitive to the weight of debt payments $r_{l\,-1}\ .l_{\,-\,1}$. "*The initial finance provided by banks to allow production is in all cases larger than the final finance requirements of firms at the end of the period. If finance has been granted to start the production process, problems of credit restraints cannot arise at the end of the accounting period*" (Lavoie, 2001, p.14).

In the same way, the central bank (i) fixes a key rate r_a[18] and (ii) provides whatever advances *A* demanded by banks at this rate:

(49) $r_a = r_{a\,0}$ with $r_{a\,0}$: constant

(50-vii) $A \equiv Bb + L + H_b - D$

The later equation corresponds to an overdraft financial system as in continental Europe. However, our model does not describe a *pure* overdraft economy: private banks wish

[17] In June 2005 in France, r_a (bottom rate) is 2% and r_l (ten-years-rate) is 4.8%.

[18] In France the central bank (ECB) has in reality three key rates: the requirements rate (*taux marginal de rémunération des dépôts*) which is actually 1%, the bottom rate (*taux repos* or *taux plancher*) at 2% and the ceiling rate or discount rate (*taux plafond* or *taux d'escompte*) at 3%. We can consider that r_a = 2% since all the central bank advances are actually made at the bottom rate but in reality the central bank is fully accommodating at the ceiling rate (which is used in exceptional situations).

to hold a certain proportion of their assets in the shape of safe Treasury bills. We assume that they demand bills on the basis of an exogenous banking liquidity ratio BLR that expresses their liquidity preference:

(51) $B_b = BLR \cdot L$ with BLR: constant

When their liquidity preference is on the rise, banks wish to hold a higher proportion of safe assets and the bills-to-loans ratio *BLR* is rising. In this model if banks wish to hold more bills, everything else being equal, they will need to borrow more from the central bank. This assumption explains that when the model is subjected to simulation, the value of BLR do not play any role (appendix 3). Godley (1999) proposes a more satisfactory approach of banking liquidity ratio that is based on a reaction function of private banks and an endogenous deposit rate.

In our model without inflation, the rate on Treasury bills is the same as the central bank key interest rate[19]:

(52) $r_b = r_a$

How is the central bank able to sustain a fixed rate of interest whatever the demand for bills of households and private banks and whatever the fluctuations in the government deficit? It is possible because the central bank is the residual purchaser of bills: it purchases however many of the bills issued by the government that households and private banks are not willing to hold given the interest rate. In other words "*the central bank clears the market at the price of its choice by providing an endogenous demand for bonds* " (Lavoie, 2001: p.15):

(53-xiii) $B_{cb} \equiv B - B_h - B_b$

This is another feature of the PK theory. In the neoclassical view the bills rate is endogenous and the money supply exogenous so that the central bank decides arbitrarily of the proportion of the deficit that will be financed by bonds issues and by the creation of high powered money. "*In the post-Keynesian view, cash is provided on demand to the public. The government, or the central bank does not decide in advance on the proportion of the deficit that will be "monetized". This proportion is set by the portfolio decisions of the households, at the rate of interest set from the onset by the monetary authorities*" (Idem).

Banks apply a spread m_2 between the rate on loans and the rate on deposits in order to realize profits P_b[20]:

(54) $r_d = r_l - m_2$ with m_2: constant

(55-vi) $P_b \equiv r_{l\,-1} \cdot L_{-1} + r_{b\,-1} \cdot B_{b\,-1} - r_{d\,-1} \cdot D_{-1} - r_{a\,-1} \cdot A_{-1}$

Since the central bank is collecting interest payments on bills and advances while paying out no interest on the notes, it is also making profits P_{cb}:

(56-viii) $P_{cb} \equiv r_{a\,-1} \cdot A_{-1} + r_{b\,-1} \cdot B_{cb\,-1}$

[19] In France the bottom rate (one-day-rate) is 2% while the rate on Treasury bills (three-months-rate) is 2.1%. The gap is not linked to a risk premium (since bills are safe assets) but to expected inflation.

[20] In this model we assume that $m_1 < m_2$ so that $r_d < r_a$. In fact it is hard to determine r_d which is an *average* rate on deposits. In France the average rate on *time deposits* is about 2.5% but *current accounts* are usually not paid. At this time, *La Caisse d'Epargne* is the first French bank that pays for current accounts using the requirements rate of the central bank (1%).

It is assumed, in line with current practice, that any profits realized by the central bank are reverted to the government.

Our model is now closed. We have defined the 29 variables of the transactions matrix introducing 27 new variables[21] and we now have the same number of equations (56) as unknowns. Furthermore, we have managed to use the M + N – 1 = 12 accounting identities issued from the transcription of the transactions matrix. The missing identity is the one relative to the capital account of the central bank:

(ix) $H \equiv A + B_{cb}$

This identity reflects the fact that base money is supplied to the economy through two channels: purchases of treasury bills and advances to private banks. Of course, this accounting identity must invariably hold. When we solve the model we have to verify that the numbers issued from simulations do generate $H \equiv A + B_{cb.}$ As Lavoie and Godley have underlined "*it is only when an accounting error has been committed that the equality given by the missing equation will not be realized. With the accounting right, the equality must hold*" (2001-2: p294). When we solve numerically our model, identity (ix) perfectly holds.

(4) Experiments[22]

Given the complexity of the model, it would be difficult to find analytical solutions. We therefore make simulation experiments using the E-views 4.0 software and following the methodology used by Lavoie and Godley: "*First we assigned values to the various parameters using reasonable stylised facts. Then, we solved the model and found a steady-state solution through a process of successive approximations. Having found a steady sate, we conducted experiments by modifying one of the exogenous variables or one of the economically significant parameters of the model at a time*" (Ibid: p.296). There is nothing original about this methodology: it is the one used by orthodox economists for their dynamic models[23]. As for PK economists in general and Circuitists in particular, they show a strong disturb for the notion of *steady state*. In fact Lavoie and Godley use it only as an analytical tool but they themselves recognize that such a theoretical construct is never reached in practice because parameters and exogenous variables are actually changing all the time (Lavoie and Godley, forthcoming: introduction). That's why when making simulation, it is important to make the difference between the initial effects of some change (in the early periods of the dynamic response) and the terminal effects (in the steady state). "*These terminal effects will eventually arise as long as the structure of the model is left unchanged, although we know that this is unlikely*" (Idem).

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[21] These 27 new variables are the following:
for the government: gr_y, T_y, Y, T_p, T_w, T_v, DG
for the firms: K, gr_k, r_{cf}^a, r_{cf}, l, u, Y_{fc}
for the households: Y_w^a, Y_v^a, Y_w, Y_v, Y_h, V_h, CG, V_h^a, Y_h^a, CG^a, r_e^a, P^{da}, E

[22] The values of our parameters and exogenous variables can be found in the appendix. The E-views program is available from Tarik on request.

[23] For example MERCADO, KENDRICK and AMMAN (1998) describe the same methodology for modelling orthodox dynamic macro models with the GAMS software.

The reader can find in the appendix a table that tries to summarize the impact of each parameter on the main endogenous variables of the model. However, space considerations prevent us from discussing every experiment. For each sector, we have just selected the experiments corresponding to the main results of the Circuit theory and we explain them briefly. Further explanations on similar experiments can be found in Lavoie and Godley (2001-2) or Dos Santos and Zezza (2004).

- Government: gr_g ($=\Delta G/G_{-1}$), τ_1

The government can intervene on its expenditure or on the various tax rates. In our model, there is no parameter corresponding to the government expenditure because the search of a steady state requires postulating that public expenditures are growing at the same rate as the national income. However, once we have obtained a steady state, we can study what happens if the government slightly raises the growth rate of its expenditures gr_g. This permanent increase moves the economy to a higher growth path generating both a rise in the utilization rate and in the ratio of cash flows. This is coherent with the Circuit theory: public expenditures correspond to sure receipts for firms and can reduce the lender's risk of private banks. In our model, the increase in government receipts (due to taxes on higher national income) is not sufficient to balance the increase in government payments (due to higher expenditure and to an increase in payments of the stock of bills which rise initially to finance the increase in expenditure): in the long run the government deficit turns out to be higher, as a ratio to output, than in the base period. All of these effects are shown in figure 1, where, as in all following figures, the various series are expressed as a ratio of the steady-state base case.

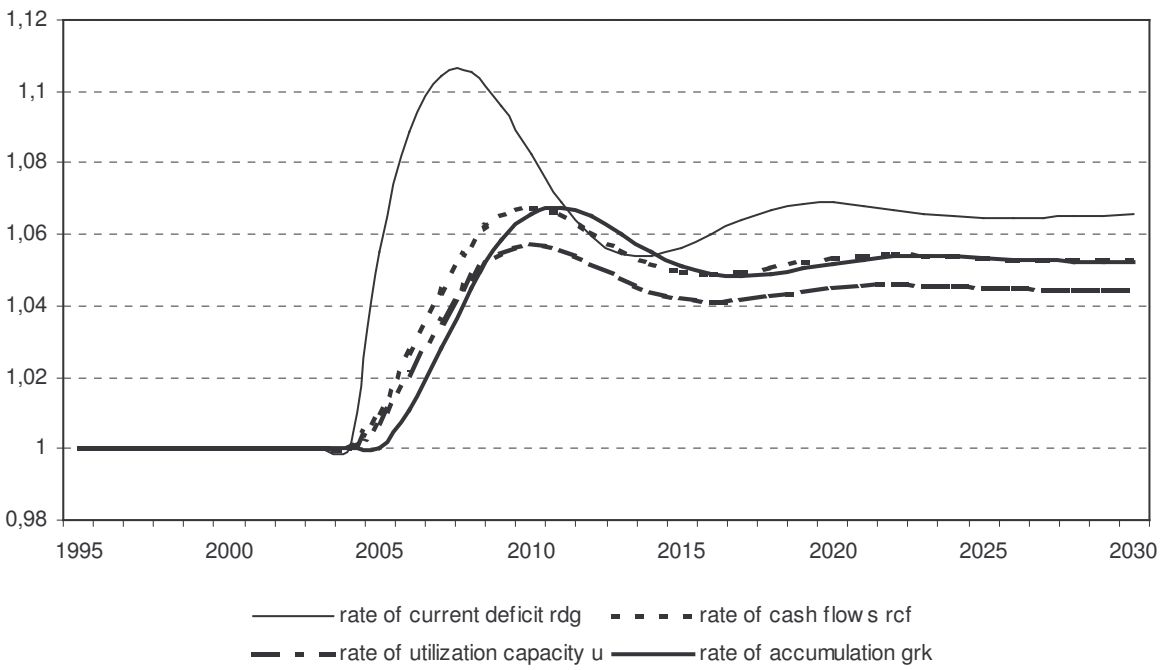

Figure 3 : Higher government expenditure

An increase in one of the various tax rates has the opposite effects. For instance, a permanent increase in the tax rate on sales τ_1 reduces the government deficit but slows down growth with a fall in u and r_{cf}. However this result is not due to a negative impact on the incentive to work (as in the mainstream literature). It occurs because taxes take out money from the circuit.

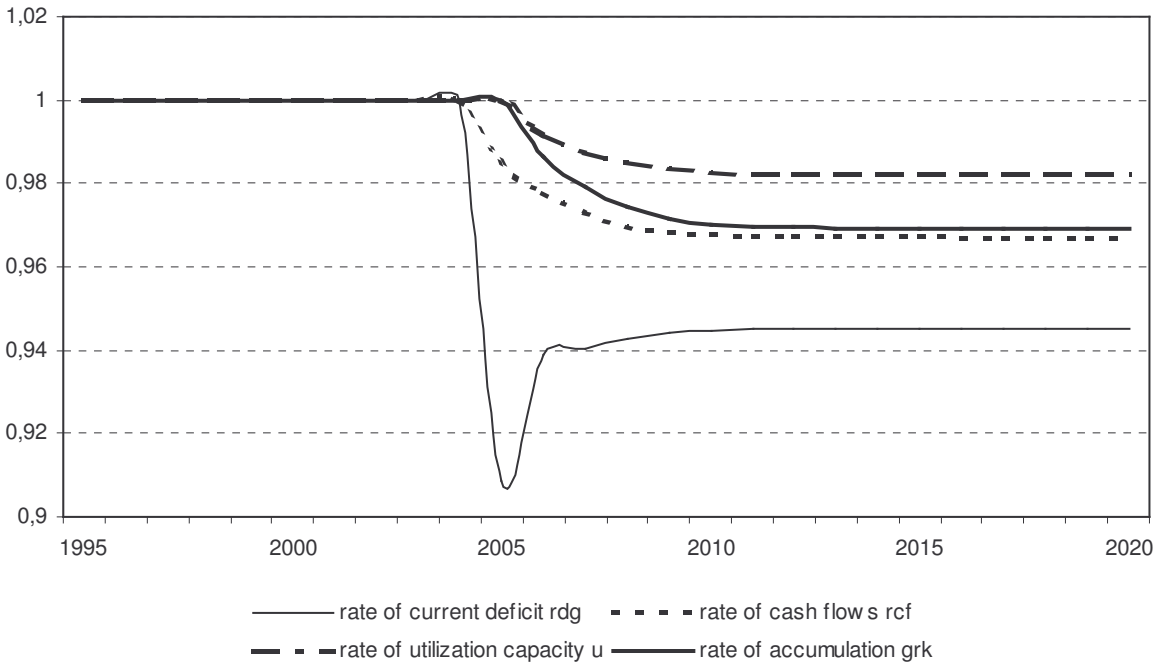

Figure 4 : Higher tax rate on sales (τ_1)

- Firms: s_f

As in Lavoie and Godley model, an increase in the retention ratio of firms has two contradictory effects on effective demand. "*On one hand, it automatically increases the cash flow* (...) *thus pushing up the investment function. In addition, firms have to borrow less and hence can reduce their debt ratios. On the other hand, households are left with less regular income, and hence, the rate of growth of consumption demand slows down*"(Lavoie and Godley, 2001-2, p.306). In Lavoie and Godley model the negative effects finally overwhelm the positive ones but with our chosen parameters an increase in the retention ratio has a positive impact on the rate of growth of the economy (despite a negative effect on u).

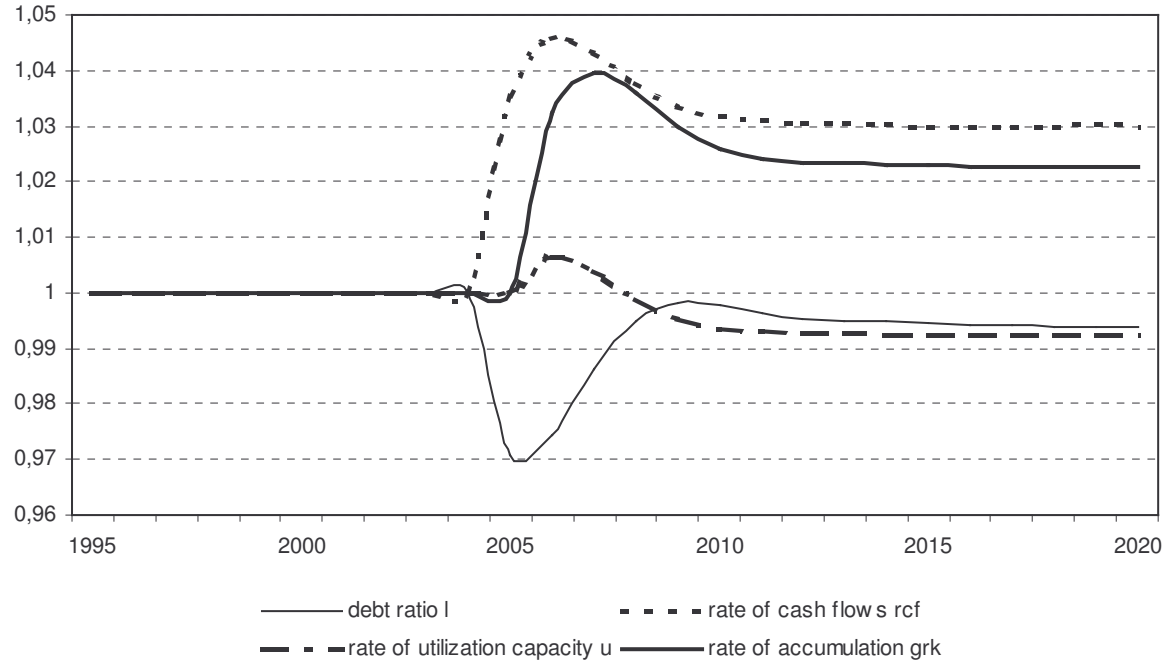

Figure 5 : Higher retention ratio (s_f)

- Households: α_1, λ_{20}

In our PK model, an increase in the propensity to consume α_1 leads to higher rate of utilization and higher rates of profit, both of which encourage entrepreneurs to increase the rate of accumulation. Hence, a drop in the propensity to save brings about faster growth. This is the famous *paradox of savings* which is a feature of Keynesian models in contrast to neoclassical models of endogenous growth where the opposite occurs.

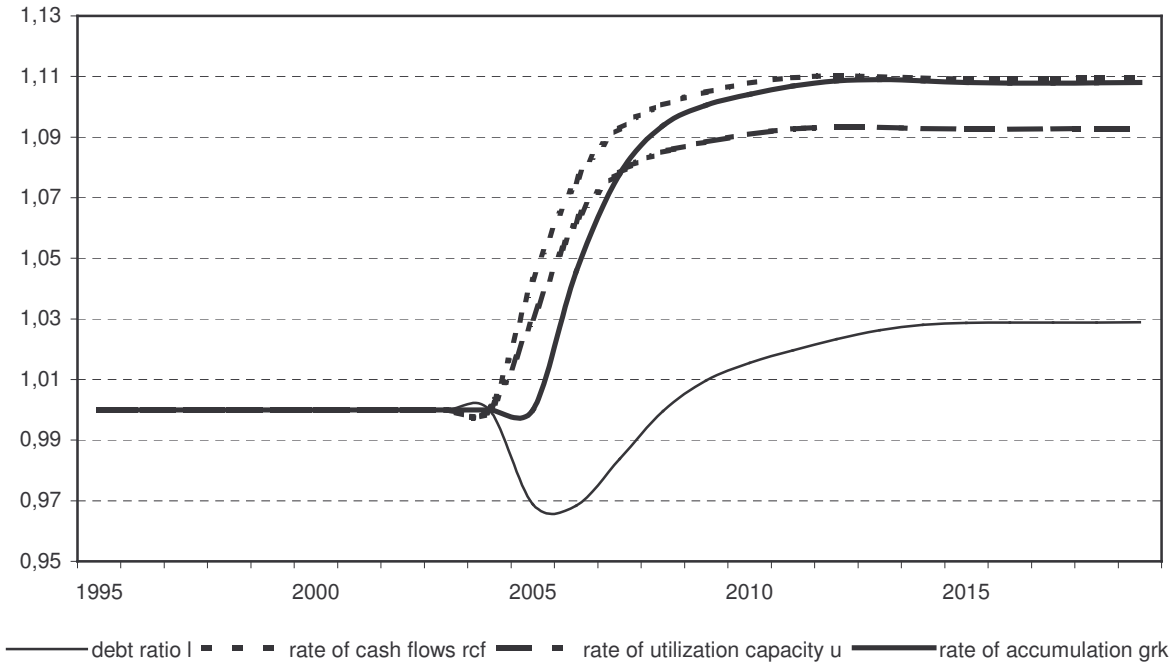

Figure 6 : Higher propensity to consume (α_1)

A shift in liquidity preference, out of money deposits and into equities, symbolized by an increase in the λ_{20} parameter of the portfolio equations leads to an increase in the rate of accumulation. This favourable effect can be attributed to two standard effects. On one hand the increase in the stock demand for equities pushes the price of equities and create capital gains thus raising the rate of capacity utilization. On the other hand, the increase in the demand for equities pushes down the leverage ratio which also contributes to the faster accumulation rate of the firms. These results illustrate the PK assertion that liquidity preference does matter in a monetary economy.

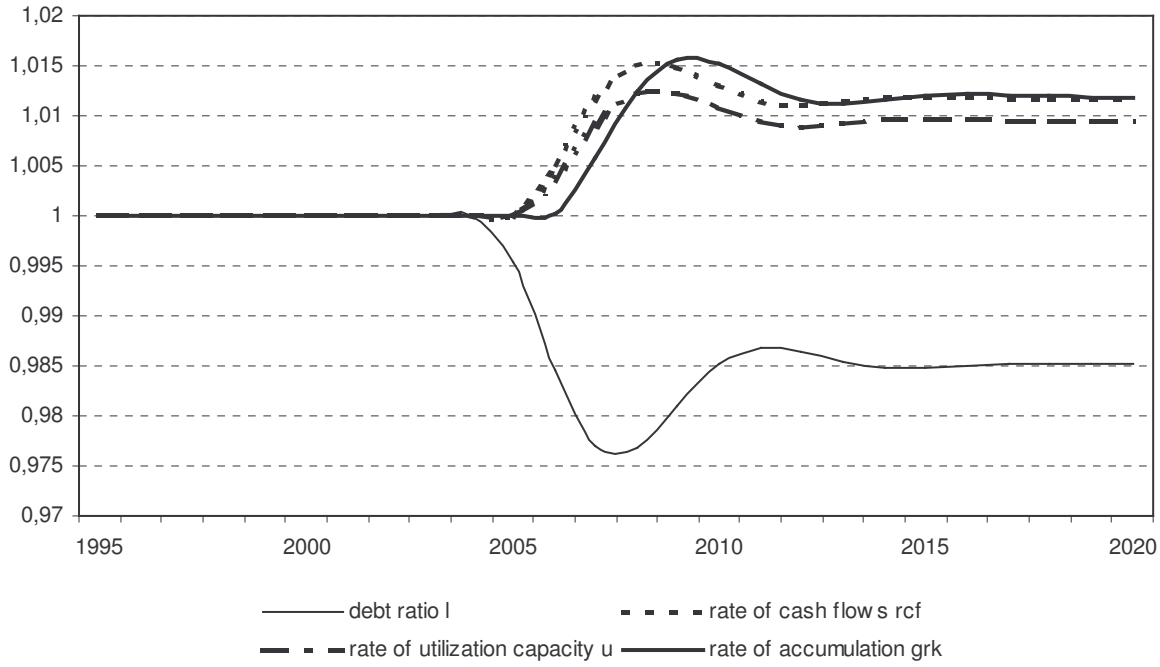

Figure 7 : Stonger preference for equities (λ_{20})

- Banking system: r_a, m_1, γ_2

Let us consider now an increase in the interest rate on central bank advances r_a[24]. With such a rise, it is in fact the entire structure of interest rates that shifts upwards. The rise in central bank key rate increases automatically the rates on loans, deposits and bills. Households therefore increase their demand for bank deposits and Treasury bills while reducing their demand for equities thus generating a fall in the price of equities.

Basically, the increase in the structure of interest rates has two effects on effective demand. On one hand the increase in the rate on loans has a negative impact on investment through higher interest payments and smaller retained profits. But on the other hand an increase in interest rates has a favourable effect on consumption demand and hence on the rate of capacity utilization since more income is now being distributed to households. However

[24] Usually the central bank raises its key rate when the economic activity, the inflation rate and the stocks of financial assets are rising. This is known as the *reaction function* of the central bank. However the Horizontalists prefer to continue considering the key rate as an exogenous variable since central bank's decisions stay discretionary.

the drop in the price of equities generates negative capital gains with a negative impact on wealth and consumption.

In our model the negative effects are initially strongest: an increase in the interest rate on central bank advances generates adverse effects on all determinants of investment. But in the long period the positive effects tend to play a greater role and the evolution of all these determinants is reversed. Finally our virtual economy stabilizes on a lower growth path (in accordance with the Keynesian literature) characterized by a lower rate of cash flows but also by a higher capacity rate and a lower leverage ratio.

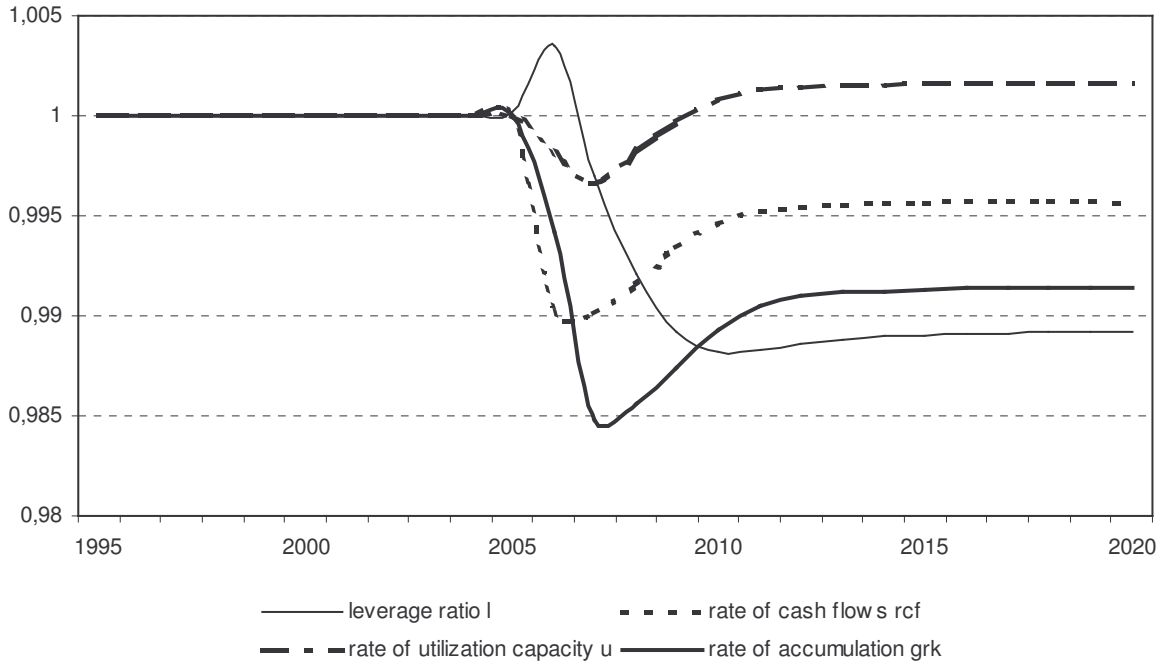

Figure 8 : higher rate on central bank advances (r_a)

PK economists have generalized the concept of liquidity preference to private banks. Such a liquidity preference is an indication of banks' prudence, a measure of their confidence in the future. When banks become more pessimistic, their liquidity preference increases with two consequences.

On one hand the interest rate on loans become higher. As banks fear that more borrowers could become insolvent, they try to protect their rate of return applying a higher mark up m_1 on central bank's key rate. As we have just seen, this increase in the rate on loans has negative impact on investment through higher interest payments and smaller retained profits. It also generates higher bank profits: since bank profits are transferred to households this can induce positive effect on consumption demand and hence on the rate of capacity utilization (because sales growth rate become higher than capital growth). That's why the steady-state rate of utilization ends up at its starting value. As for the debt ratio, it first increases since more loans are required to balance the reduced retained profits but it decreases in the long term with the drop of investment.

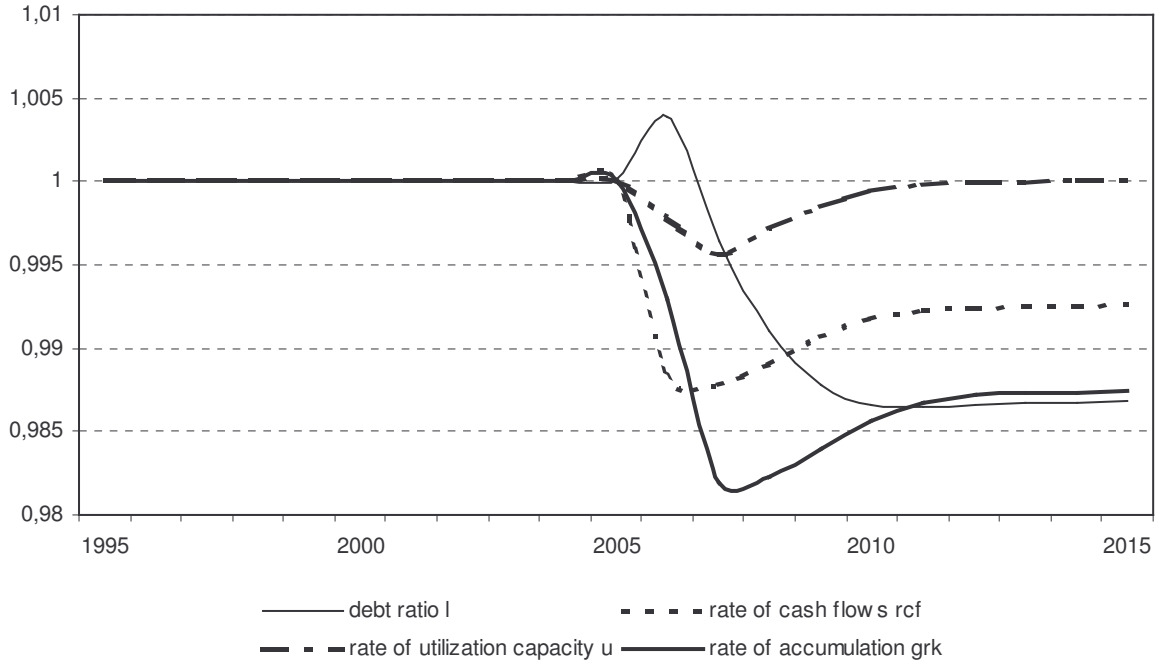

Figure 9 : Higher mark up (m_1)

On the other hand banks will have stronger requirements and credit rationing will rise at the stage of initial finance. In our model the effect of this is a rise in the value of the parameter γ_2 in the investment function. Such an increase leads to smaller debt ratio and has a negative impact on investment, cash flows and capacity utilization.

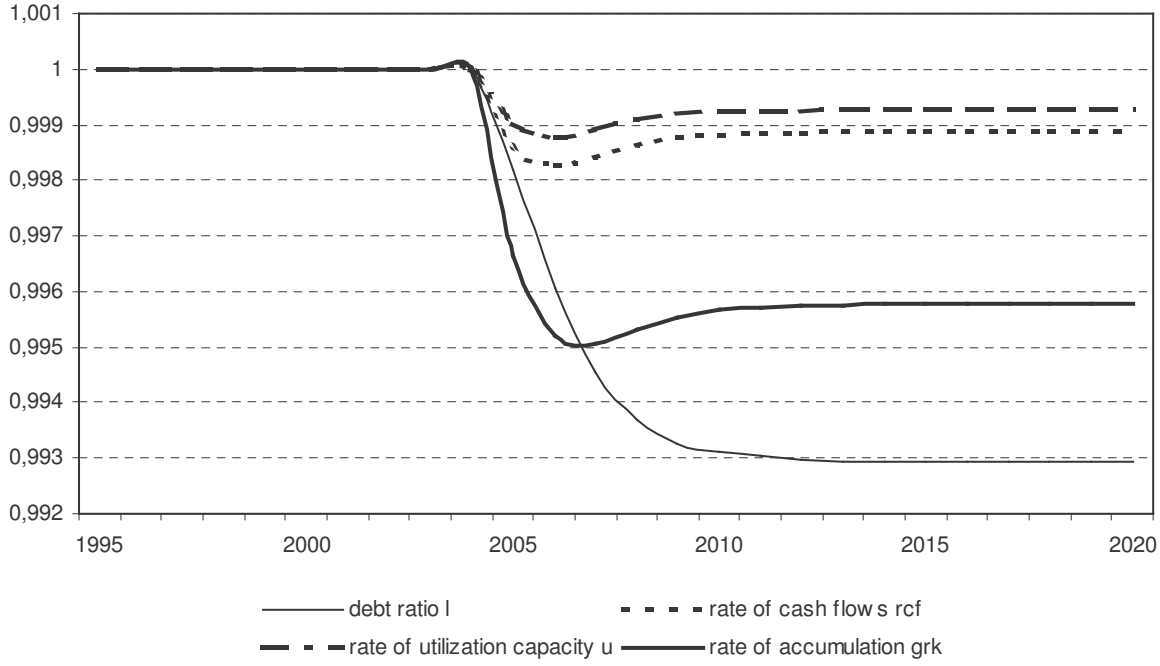

Figure 10 : Stronger credit rationing (γ_2)

CONCLUSION

In this paper we have intended to solve some problems of the Circuit theory: lack of formalism, omission of stocks and basic analysis of the banking system. However, since the Circuitists have never managed to agree around fundamental hypothesis, we don't pretend that our model is representative of all their different works and ideas. For example, we have used some results of Frédéric Poulon but we can't say that our model is a "Poulonian" one for, at least, two reasons:

The first reason is that we have not introduced the User Cost in our model. According to Frédéric Poulon, this cost, described by Keynes in Chapter 6 of the *General Theory of employment, interest and Money,* is fundamental in the explanation of economic crisis. He thinks like Karl Marx that crisis appears when entrepreneurs don't anticipate properly the rise of this cost and so don't anticipate properly the competition intensity in the economy. From a "Poulonian" point of view there is a real problem linked to the absence of the User cost in our model because errors in anticipation of competition are not considered. These errors are supposed to have consequence in the determination of such variable as investment. Actually an unanticipated rise of the competition (which raises the user cost by the depreciation of capital) will have consequences on the firm's capital value and on the investment value.

The second reason is the integration of time in our dynamic model. Every Circuitist mentioned the importance of time in the activity. They show that some decisions are taken before/after others and describe a hierarchy in economic decision. But Poulon go further: he isolates a crisis condition related to time. Like Karl MARX, he thinks that crisis appears when entrepreneurs don't have the time to recover their loans. Our model doesn't express this idea.

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Appendix 1. The complete model.

(1) $G = G_{-1} \cdot (1 + gr_{y\,-1})$
(2) $gr_y = \Delta Y / Y_{-1}$
(3) $Y = C + I + G$
(4-x) $T \equiv T_h + T_f$
(5) $T_f = T_y + T_p$
(6) $T_y = \tau_1 \cdot Y$
(7) $T_p = \tau_2 \cdot P_{-1}$
(8) $T_h = T_w + T_v$
(9) $T_w = \tau_3 \cdot W_{-1}$
(10) $T_v = \tau_4 \cdot V_{h\,-1}$ with τ_i : constants
(11-i) $B \equiv B_{-1} + DG$
(12) $DG = G + r_{b\,-1} \cdot B_{-1} - T - P_{cb}$

(13) $I = gr_k \cdot K_{-1}$
(14) $K = K_{-1} + I$
(15) $gr_k = \gamma_1 .r_{cf}{}^a - \gamma_2 .r_{l\,-1} .l_{-1} + \gamma_3 .u_{-1}$ with γ_i : constants
(16) $r_{cf}{}^a = r_{cf\,-1} + \theta_f \cdot (r_{cf-1} - r_{cf}{}^a{}_{-1})$ with θ_f : constant
(17) $r_{cf} = P^u / K_{-1}$
(18) $l = L / K$
(19) $u = Y / Y_{fc}$
(20) $Y_{fc} = K_{-1} / \sigma$ with σ: constant
(21) $W = Y \cdot (1 - \tau_1) / (1 + \rho)$ with ρ: constant
(22-ii) $P \equiv C + I + G - W - T_f - r_{l\,-1} \cdot L_{-1}$
(23) $P^d = (1 - s_f). P_{-1}$ with s_f : constant
(24-xi) $P^u \equiv P - P^d$
(25) $e = e_{-1} + x \cdot I_{-1} / p_e$ with x : constant
or (25'') $e = (1+gr_e) \cdot e_{-1}$ with gr_e : constant

(26) $C = \alpha_1 .Y_w{}^a + \alpha_2 \cdot Y_v{}^a + \alpha_3 .V_h{}^a$ with α_i : constants $1>\alpha_1>\alpha_2>\alpha_3>0$
(27) $Y_w{}^a = Y_{w\,-1} + \theta_h \cdot (Y_{w-1} - Y_w{}^a{}_{-1})$ with θ_h : constant
(28) $Y_v{}^a = Y_{v\,-1} + \theta_h \cdot (Y_{v-1} - Y_v{}^a{}_{-1})$
(29) $Y_w = W - T_w$
(30) $Y_v = r_{d\,-1} \cdot D_{-1} + r_{b\,-1} \cdot B_{h\,-1} + P^d + P_b - T_v$
(31-iv) $S \equiv Y_h - C$
(32) $Y_h = Y_w + Y_v$
(33-v) $V_h \equiv V_{h\,-1} + S + CG$
(34) $CG = \Delta p_e .e_{-1}$
(35) $V_h{}^a = V_{h\,-1} + Y_h{}^a - C + CG^a$
(36) $Y_h{}^a = Y_{h\,-1} + \theta_h \cdot (Y_{h-1} - Y_h{}^a{}_{-1})$
(37) $CG^a = CG_{-1} + \theta_h \cdot (CG_{-1} - CG^a{}_{-1})$

(38) $H_h = \eta_h \cdot C$ with η_h : constant

(39) $r_e^a = (P^{d\,a} + CG^a) / (p_{e\,-1} \cdot e_{-1})$

(40) $P^{d\,a} = P^{d\,a}_{-1} + \theta_h \cdot (P^d_{-1} - P^{da}_{-1})$

(41) $B_h = (\lambda_{10} + \lambda_{11} \cdot r_b - \lambda_{12} \cdot r_e^a - \lambda_{13} \cdot r_d) \cdot (V_h^a - H_h)$ with λ_{ij} : constants

(42) $E = (\lambda_{20} - \lambda_{21} \cdot r_b + \lambda_{22} \cdot r_e^a - \lambda_{23} \cdot r_d) \cdot (V_h^a - H_h)$

(43-xiv) $D \equiv V_h - H_h - B_h - E$

(44) $p_e = E / e$

(45) $H_b = \eta_b \cdot D$ with η_b : constant

(46-xii) $H \equiv H_h + H_b$

(47) $r_l = r_a + m_1$ with m_1: constant

(48-iii) $L \equiv L_{-1} + I - P^u - \Delta e \cdot p_e$

(49) $r_a = r_{a\,0}$ with $r_{a\,0}$: constant

(50-vii) $A \equiv Bb + L + H_b - D$

(51) $B_b = BLR \cdot L$ with BLR: constant

(52) $r_b = r_a$

(53-xiii) $B_{cb} \equiv B - B_h - B_b$

(54) $r_d = r_l - m_2$ with m_2: constant

(55-vi) $P_b \equiv r_{l\,-1} \cdot L_{-1} + r_{b\,-1} \cdot B_{b\,-1} - r_{d\,-1} \cdot D_{-1} - r_{a\,-1} \cdot A_{-1}$

(56-viii) $P_{cb} \equiv r_{a\,-1} \cdot A_{-1} + r_{b\,-1} \cdot B_{cb\,-1}$

Missing equation: (57-ix) $H \equiv B_{cb} + A$

Appendix 2. Parameters and initial stocks.

$\tau_1 = 0.05$ (0.06) $\tau_2 = 0.3$ $\tau_3 = 0.3$ $\tau_4 = 0.05$
$\gamma_1 = 1.25$ $\gamma_2 = 1.25$ (1.4) $\gamma_3 = 0.5$
$\theta_f = 0.1$
$\sigma = 0.13$
$\rho = 0.4$
$s_f = 0.75$ (0.8)
$x = 0.25$ or $gr_e = 0.05$
$\alpha_1 = 0.8$ (0.9) $\alpha_2 = 0.5$ $\alpha_3 = 0.15$
$\theta_h = 0.1$
$\lambda_{10} = 0.4$ $\lambda_{11} = 0.2$ $\lambda_{12} = 0.1$ $\lambda_{13} = 0.1$
$\lambda_{20} = 0.5$ (0.55) $\lambda_{21} = 0.1$ $\lambda_{21} = 0.2$ $\lambda_{23} = 0.1$
$\eta_h = 0.2$
$\eta_b = 0.25$
$r_{a\,0} = 0.02$ (0.03) $m_1 = 0.028$ (0.04) $m_2 = 0.038$
BLR = 0.2

(Values used for the experiments are written between brackets)

$K = 250$
$H = 80$ $H_h = 60$ $H_b = 20$
$B = 100$ $B_h = 60$ $B_b = 30$ $B_{cb} = 10$
$E\ (= e \cdot p_e) = 150$
$D = 80$
$L = 100$
$A = 70$
$V_f = 0$
$V_h = 350$

Appendix 3. Impact of each parameter on the main endogenous ratios.

	gr_k			u			r_{cf}			r_{dg}= DG/Y		
τ_1	↓			↓			↓			↓	↑	<
τ_2	↓			↓	↑	<	↓			↓	↑	<
τ_3	↓			↓			↓			↓	↑	<
τ_4	↓			↓			↓			↓	↑	<
$\gamma 1$	↑	↓	>	↑	↓	>	↑	↓	>	↓	↑	>
$\gamma 2$	↓	↑	<	↓	↑	<	↓	↑	<	↑	↓	>
$\gamma 3$	↑	↓	>	↑	↓	>	↑	↓	>	↓	↑	<
θ_f	=			=			=			=		
σ	↑	↓	>	↑	↓	>	↑	↓	>	↓	↑	<
ρ	↑	↓	>	↑	↓	<	↑	↓	>	↓	↑	<
s_f	↑	↓	>	↑	↓	<	↑	↓	>	↓	↑	<
gr_e/x	↑	↓	>	↓			↓			↑		
α_1	↑			↑			↑			↓		
α_2	↑			↑			↑			↓		
α_3	↑			↑			↑			↓		
θ_h	↑			↑			↑			↓		
η_h	↓	↑	<	↓	↑	<	↓	↑	<	↑	↓	>
λ_{10} (↓ λ_{30})	↑			↑			↑			↑	↓	>
λ_{20} (↓ λ_{30})	↑	↓	>	↑	↓	>	↑	↓	>	↓	↑	<
η_b	↓			↓			↓			↓		
m_1 (↑r_l)	↓	↑	<	↓	↑	=	↓	↑	<	↑	↓	>
m_2 (↓ r_d)	↑	↓	>	↑	↓	>	↑	↓	>	↓	↑	<

r_{a0}	↑	↓	>	↓	↑	>	↓	↑	<	↑	↓	>
BLR	=			=			=			=		

When the initial effect of some change is different than the terminal one, we precise the global effect corresponding to the new steady state. Usually this global effect corresponds to the initial one (otherwise it is printed in bold).

Ex: A rise in the tax rate on sales $\boldsymbol{\tau_1}$ leads to:

- a decrease in the accumulation rate $\mathbf{gr_k}$
- a decrease in the rate of utilization **u**
- a decrease in the rate of cash flows $\mathbf{r_{cf}}$
- an initial decrease and a final increase of the government's deficit-to-output ratio $\mathbf{r_{dg}}$. The value of this ratio is smaller in the new steady state than in the initial one.

Note that these results are only qualitative. For instance, it appears that a rise in the reserves ratio $\boldsymbol{\eta_b}$ leads to a decrease in the rate of accumulation but this effect is probably minuscule.