The fundamental mechanism behind the global financial crisis

Trond Andresen <trond.andresen@itk.ntnu.no>
The Norwegian University of Science and Technology
Faculty of Information Technology, Mathematics and Electrical Engineering
Department of Engineering Cybernetics
N-7491 Trondheim, NORWAY

October 22, 2012

Abstract

Any economic system with interest on money lent has the potential to gradually develop a level of debt that leads to crisis. It is argued that the problem of "slowly exploding" debt is grave but (until recent events) largely ignored. The paper employs tools from System Dynamics.

Keywords: accumulation, instability, lending, compound interest dynamics

JEL classification: B50, C02, C60, C67

Figure 1 shows money circulation with firms and households in a macroeconomic setting. Households receive income flows of wages (W) and profits (Π) (it is assumed that firms are owned by part of households). And households use their income to consume (C) or invest (I). Most households only consume and don't invest, and they only receive wages and no profits (but the share of households being stock owners does not have any bearing on the issues discussed in this paper). The four entities W, Π, C, I are *flow* variables [$\$/y$]. Firms also buy from each other as indicated by the money flow arrows within the firms aggregate. At any time any firm and household have some stock of money[$\$$] as a buffer for its participation in the circulatory system. Summing up all the individual stocks, we get the aggregate amount of money in circulation among firms and households, which we will call M.

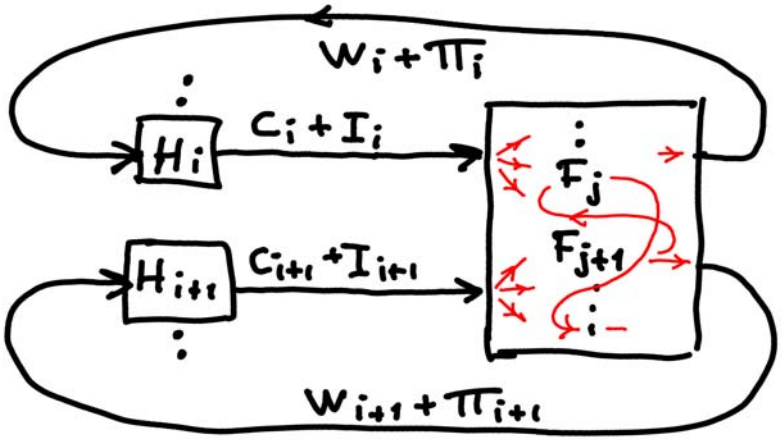

Figure 1: Money circulation with households and firms. No banks yet.

1 A model of *financial accumulation.*

Any economic system with interest on lent money has the potential to gradually develop a level of debt that leads to crisis. The model consists of a financial sector which re-lends part of financial inflows from debt service on existing loans so that the aggregate of loans will grow and future financial income will be correspondingly larger. At the other end is the rest of the economy introduced above – the "real economy": households and non-financial firms, where the aggregate flow Y is now the sum of all $C + I$ flows. The real economy is in debt, but still borrows (and in later stages have to borrow) what the banks offer. The units are macroeconomic aggregates, so that we have a society which is increasingly polarised between a group of lenders and a group of borrowers. See figure 2. The positive feedback from debt service to new loans is indicated with plus signs. *(Note that this is not strictly the syntax of a causal diagram, it is only used at this stage for explanatory purposes.)*

Wages and expenses paid by the financial sector may, seen from the financial sector's side, be considered a "leakage" back to the real economy that weakens the accumulation process. Note that the money flowing to banks as interest and repayment is in its entirety returned to the real economy, after some lag. Abstracting from the effects of the lag in the financial sector, this means that money will not disappear from the real economy; all of it will be cycled back. Due to accumulation however, it will to an increasing degree come back with strings attached – appearing as added debt. So we have a growth of the positive feedback flows to and back again from the financial sector. They may grow faster than the aggregate of transaction flows $Y(t)$ within the real economy (Y = Gross Domestic product = GDP = consumption + investment = $C + I$).

We have the relation

$$Y(t) = M(t)v(t) \tag{1}$$

where $v[1/y]$ is money velocity, the number of times a dollar turns over per year. The other variables with denominations to be used in the model are $M[\$]$, $Y[\$/y]$ and debt $D[\$]$. Parameters needed are interest $i[1/y]$ and repayment rate $d[1/y]$. We also assume a first order time lag T_b between banks receiving debt service, and extending new loans/paying expenses and wages.

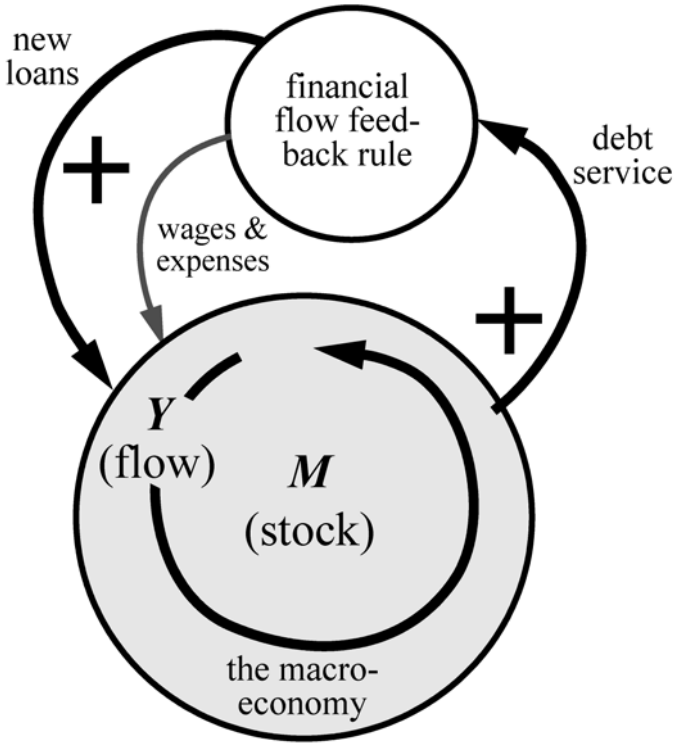

Figure 2:

Money velocity v may be considered a constant parameter, but it will become a variable and fall dramatically during the late debt crisis stage, when all agents hold back in their spending and banks hold back in their lending.

Debt service is a *non-discretionary* flow (you can't decide the size of the payment flow, it is decided by the loan contract and you are obliged by it) while the Y flows are *discretionary*, at least within some fairly flexible bounds (you have to eat, but you may postpone the purchase of a new TV or holiday). When non-discretionary flows become dominating, the economy as a whole becomes less resilient and more fragile. The frequency of insolvencies increases.

An economic system with lenders recycling financial income as new loans will as a rule become polarised betwen lenders and borrowers, as warned against since ancient times. For all financial investors (lenders) strive to accumulate. To the degree they succeed, we get increased asset/debt polarisation. Such polarisation occurs since only successful accumulators survive through the market's Darwinian selection process. Thus slow motion debt explosions will be the rule and not the exception – debt crises occur in the real world. During the last thirty years debt has persistently increased more than GDP's worldwide, see figure 3. *This is possibly the most fundamental (more basic than the US housing bubble and new complicated financial instruments) cause of today's global financial crisis.*

The reason that such processes are not much recognised or discussed, is probably the very long time scale for the dynamics involved (several decades), and that the growth path of an exponential function is not very noticeable until the dramatic late stage.

It also possible that the reason for lack of recognition of the basic accumulation mechanism is – paradoxically – that it is so trivially obvious if one bothers to think about it. Even antique societies recognised it. The insight's ancient origin, its close relation with religion (prohibition against interest on loans in old Christianity and current Islam), and its simplicity, all contribute to explain why fringe groups and "eccentrics" embrace it. But one should be very careful about dismissing a theory just because it is supported by the fringe. One may then have a case of a baby being thrown out with the bathwater. This seems to be done by parts of the economics profession.

Seen from a control systems perspective however (which ought also to be shared by economists), these runaway long-term dynamics are extremely harmful, and some macroeconomic control mechanism(s) should be implemented. A control strategy for a country could be to keep the debt/GDP ratio (or the debt service/GDP ratio) within some reasonably low bounds.

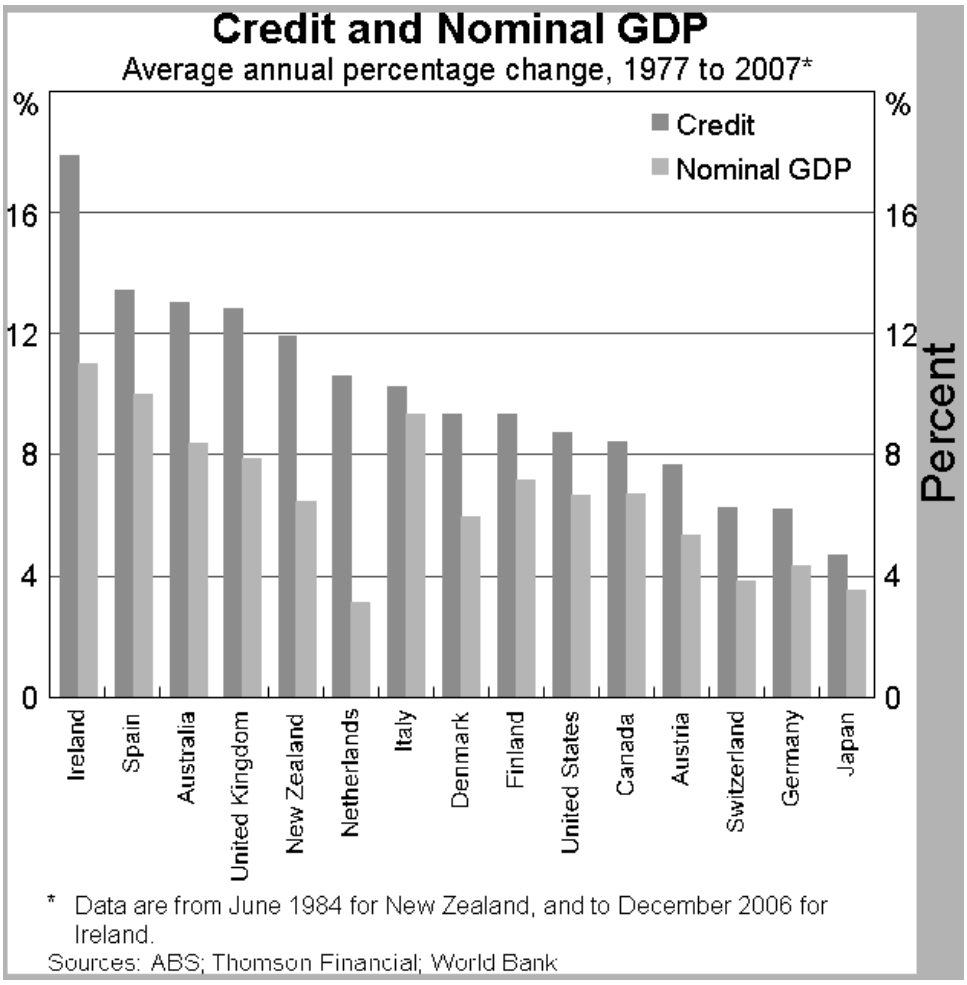

Figure 3: Debt outruns GDP in OECD countries *(courtesy: Reserve Bank of Australia)*

2 A system dynamics model

2.1 Private debt

We will build the model in five stages. All entities are in nominal, not deflated (= inflation-corrected) values. Some very simplifying assumptions are made, but (hopefully) without losing the essence of what is to be argued. The loan interest rate i and the repayment rate r are held constant. Depositors receive no interest on their bank deposits M. The aggregate "bank" is not assumed to be able to net create money when lending, even if that is allowed to some degree in actual modern economies. The aggregate bank may for explanatory purposes be thought of as a classic "moneylender" receiving physical currency from the debtors, storing it temporarily in a vault (M_b, which plays the role of a buffer), and then lending out the money again, the share left over after bank expenses and wages are paid.

Figure 4 shows the stage 1 model Three differential equations are shown in the upper left corner, corresponding to the three stocks in the stock-flow diagram. Two new parameters are introduced: $0 < \beta < 1$ is the share of interest income iD that is available for new lending after expenses are paid. T_b is the time lag of the bank buffer. Note that the total amount of money in the system is not only M, as used in the introduction above, but $M + M_b$. The total amount is constant, so that any increase in the bank buffer M_b implies a similar decrease in the amount M available for consumption and investment transactions. A further analysis of the system which will not be done here, gives the result that for any pair i and $\beta > 0$, debt D will grow exponentially. This may be shown algebraically, or via simulations. The last approach is necessary when one wants to account for the effects of dangerous debt levels in an economy, more on this in later stages.

The next stage is shown in figure 5. Here we have added the real part of the economy, with the aggregate of transaction flows $Y = Mv$. We have also added a measure of the burden of debt, the fraction $(i+r)D/Y$. We note that both the banking time lag and money velcoty are assumed exogenous

$$\frac{dD}{dt} = \dot{D} = -rD + \frac{M_b}{T_b}\left(\frac{i\beta + r}{i + r}\right)$$

$$\frac{dM_b}{dt} = \dot{M}_b = (i+r)D - \frac{M_b}{T_b}$$

$$\frac{dM}{dt} = \dot{M} = \frac{M_b}{T_b} - (i+r)D = \left[-\dot{M}_b\right]$$

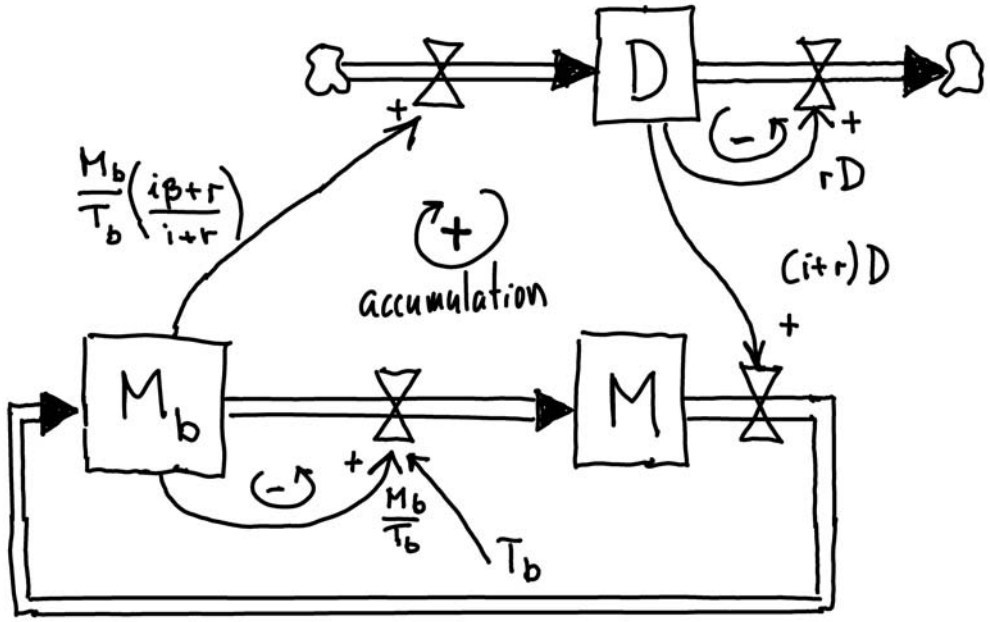

Figure 4:

and constant at this stage. This model has pure exponential debt growth as in stage 1, since there are no new closed loops influencing the stocks.

We now go to stage 3, figure 6. We have introduced a loss rate $\lambda[1/y]$, which expresses the yearly share of D lost due to bankruptcies and insolvencies. The larger the debt burden, the higher is λ. Debt is reduced. We get a balancing loop as indicated.

Then to stage 4, figure 7. Money velocity v has now become an endogenous variable. It is influenced by a new intermediate variable, "optimism", which again is influenced both by the loss rate and the current debt burden. We assume delays (or preferably 1st order information lags) at the optimism inputs, since the mood in society needs time to change. Now we get a postive feedback loop that may be dangerous: people and firms hold on to their money (reducing v) which contributes to even more reduction in optimism.

Finally, to stage 5, figure 8. Another dangerous feedback loop which exacerbates a debt-induced cris, is that banks spend and lend less when optimism is low. Then the buffer lag T_b is increased, banks hold longer on to their incoming debt service flow. In the first decades the only influential feedback loop is "accumulation". The other two reinforcing loops come into play in the end phase when the debt burden is high. Like in many countries and regions these days.

This is structurally the complete model. What remains to be able to do simulations, are some reasonable parameter values and nonlinear functional relationships.

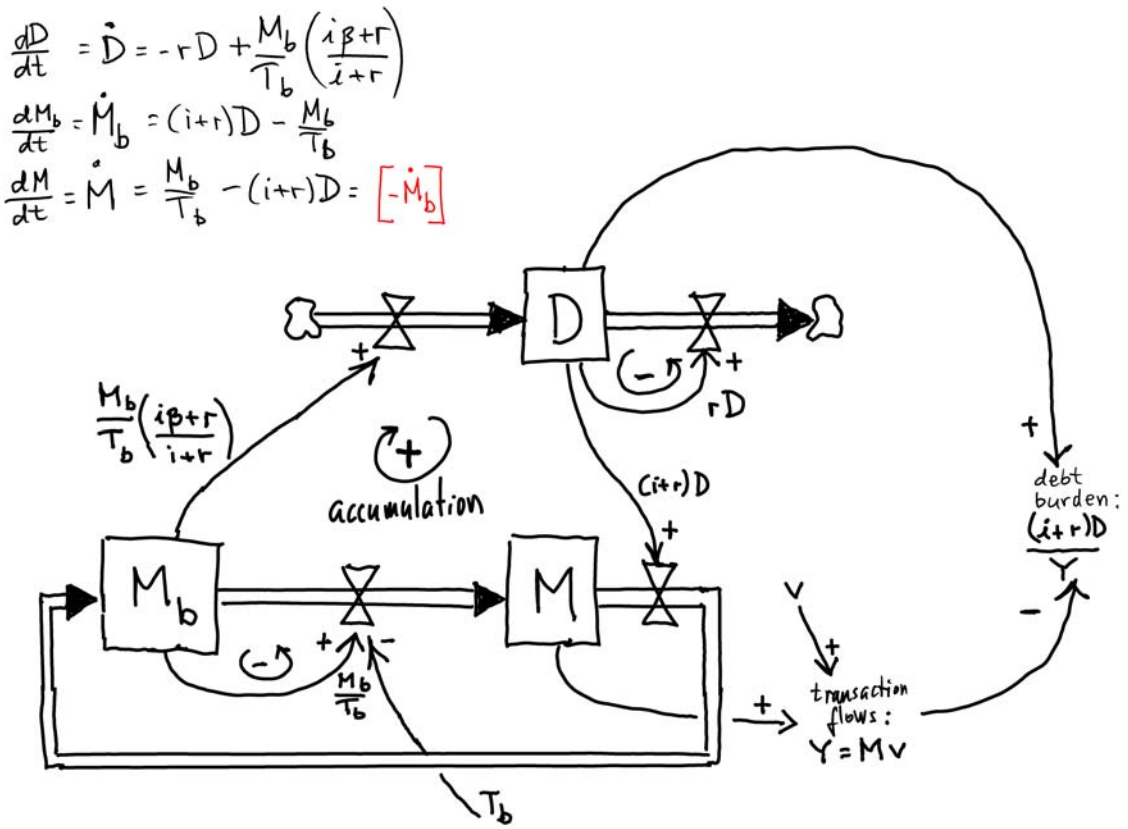

Figure 5:

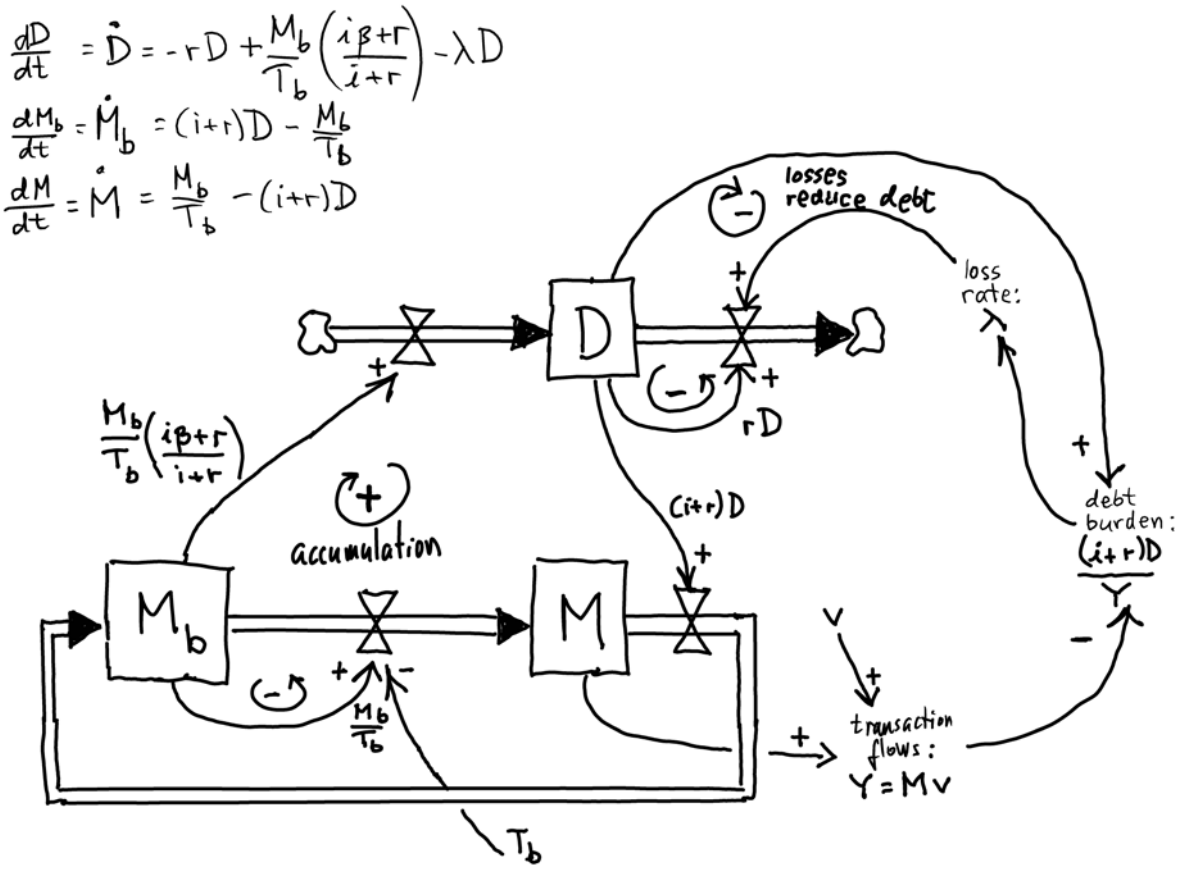

Figure 6:

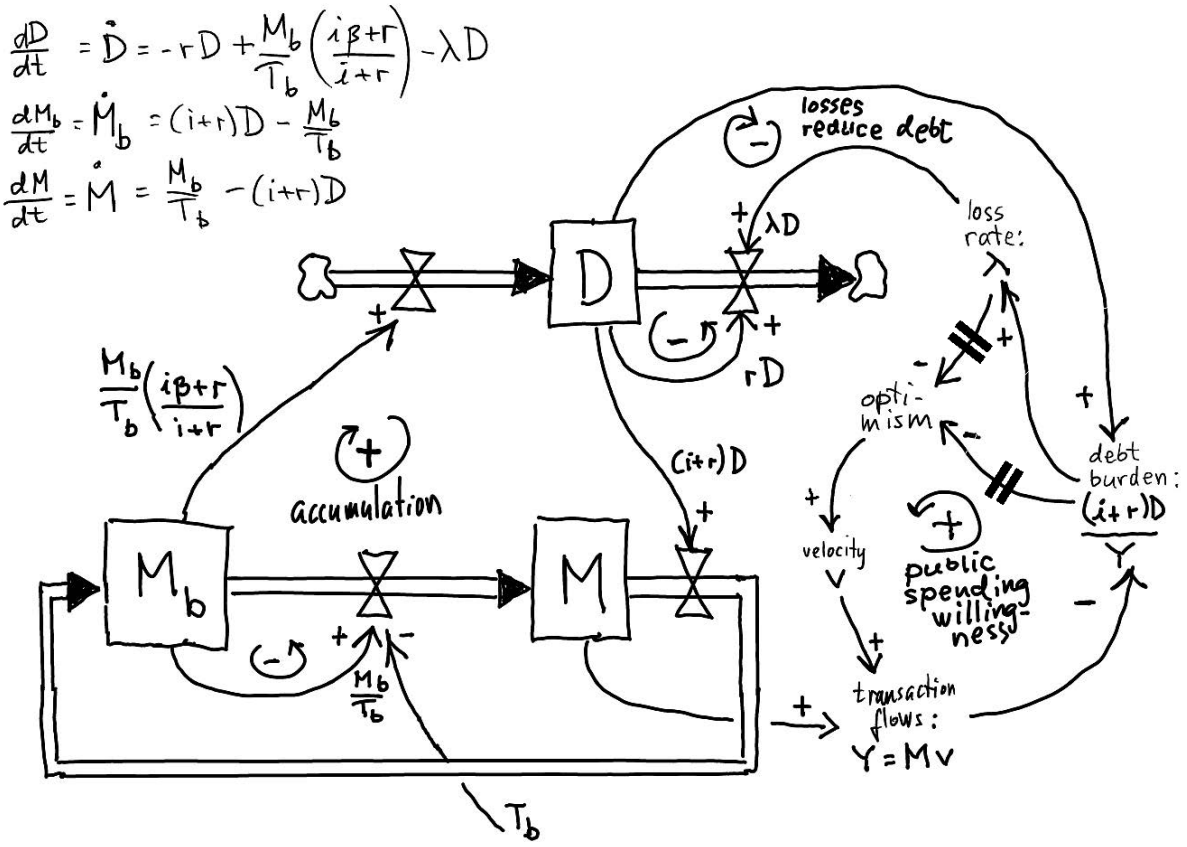

Figure 7:

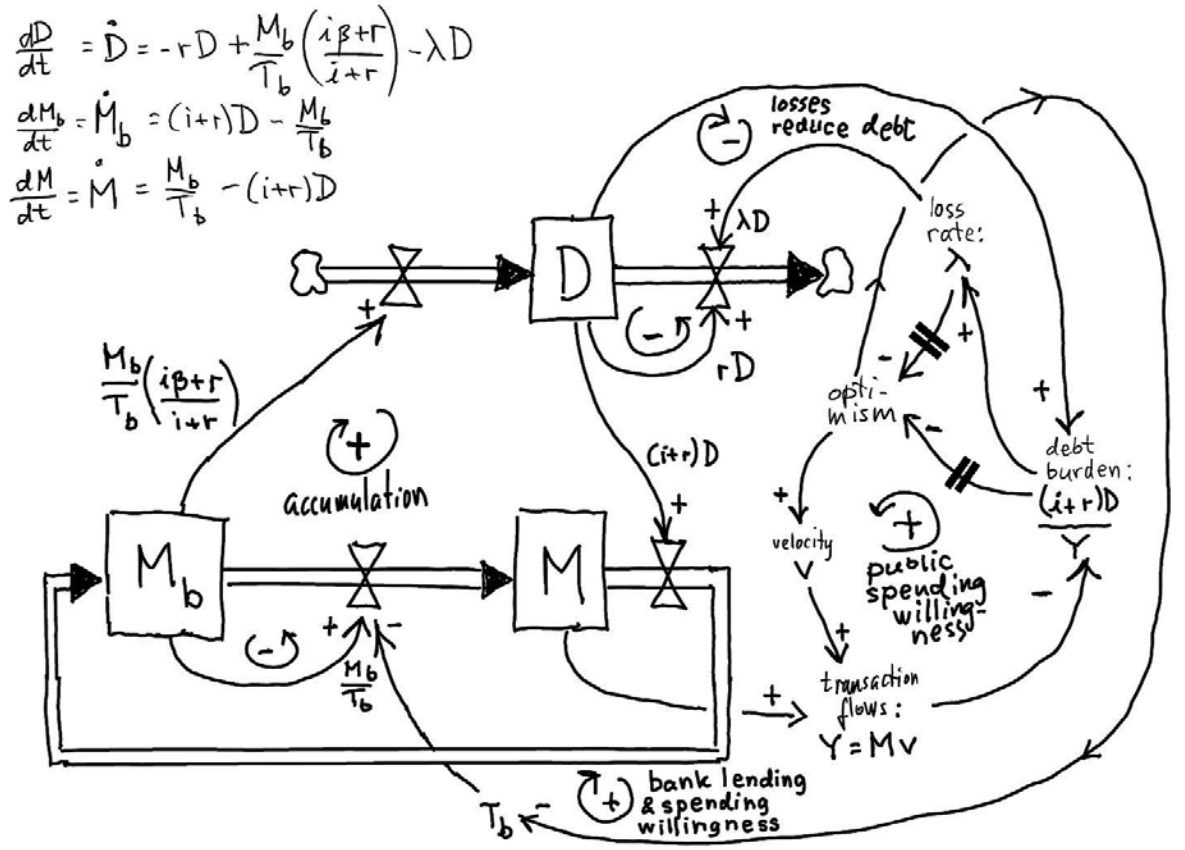

Figure 8: