

# Inclusive growth and sustainable finance - a system dynamics model

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## **Abstract**

The recent debt crises in the euro-zone and in the United States have naturally triggered controversial discussions about the cause and effect between the various socio-economic factors. Kumhof and Rancière presented a model that explores the "nexus between increases in the income advantage enjoyed by high income households, higher debt leverage among poor and middle income households, and vulnerability to financial crises" (Kumhof 2010). Bordo and Meissner, on the other hand, used "data from a panel of 14 countries for over 120 years" and found "no evidence that rising income concentration was a significant determinant of credit booms" (Bordo 2012).

In our paper we present a system dynamics model which we are developing for analyzing the relationship between economic growth and consumer debt from a financial and distribution-political perspective. Our preliminary results do not only support the findings of Kumhof and Rancière but may also explain to a certain extent why Bordo and Meissner found no evidence in their work. Understanding stock-and-flow dynamics is a key to understand and thus to prevent or overcome debt crises. Compared to austerity, achieving more income equality seems to be a better method meeting the challenge of the debt crisis. Inclusive growth can be seen as a prerequisite of sustainable finance.

## **1. Introduction**

The financial crisis starting in 2007/2008 hits the world economy hard and spreads over the globe at an incredible pace. It was the start of the largest recession since the Great Depression with a contraction of world economy by 2.1% in 2009 (Keeley 2010). Even if some economies have recovered successfully, the economic crisis is still ongoing (Roxburgh 2012). Not only Greece, Island and Slovenia are far away from pre-crisis GDP levels. For the period from 2008 to 2011, 16 OECD countries showed a negative annual growth rate in GDP (OECD 2013). The U.S., the European Union and the rest of the world are still in a struggle against high levels of debts of public and private households.

There is little doubt that rising debt levels are key drivers for financial crises. For more than one decade before the global financial crisis, debts in developed countries rose dramatically. No wonder, growth is often the first choice for policy makers to stabilize and recover economies (Roxburgh 2010). Even when governments and central banks are focusing their efforts on reducing public debts, the real source of financial crises could be ever growing private loans. Therefore, reducing private debts could be a far more promising way for mastering the actual and preventing future financial crises (Clemons 2012).

Concerning the ongoing crisis, the United Nations General Assembly states that "growth in inequality has had important consequences for the evolution and resolution of the crisis" (United Nations 2009, p.25). Policy makers, like governments, central banks, or labor organizations, are asked to reverse growing income inequality. The main questions are: how does inequality impact the probability of a financial crisis? Is inequality coincidence or

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causation for crises (Krugman 2010)? Answering these questions is essential for implementing effective policies to retain sustainable and long term growth.

Kumhof and Rancière presented a model that explores the "nexus between increases in the income advantage enjoyed by high income households, higher debt leverage among poor and middle income households, and vulnerability to financial crises" (Kumhof 2010). Bordo and Meissner, on the other hand, used "data from a panel of 14 countries for over 120 years" and found "no evidence that rising income concentration was a significant determinant of credit booms" (Bordo 2012).

In this paper we present a system dynamics model which we are developing for analyzing the relationship between economic growth and consumer debt from a financial and distribution policy perspective. Our preliminary results do not only support the findings of Kumhof and Rancière but may also explain to a certain extent why Bordo and Meissner found no evidence in their work. Compared to austerity, achieving more income equality seems to be a better method meeting the challenge of the debt crisis. Inclusive growth can be seen as a prerequisite of sustainable finance.

In the following chapter we give an overview of existing literature relevant to the research problem. In chapter 3 we describe the process of building our system dynamics model before we explain some important results gained by different simulation runs in chapter 4. The paper ends with a conclusion and an outlook of planned model extensions to overcome existing limitations.

## **2. Related works**

There are different meanings of the term "inequality", e.g. inequality of resources or opportunity (Barber 2011), or income inequality. Income inequality is regularly measured using the Gini index (OECD 2012) or, within the scope of this paper, expressed by labor share (see, e.g., Gollin 2002). "The labor share is a key indicator for the distribution of income in a country. It shows how much of national income is distributed to labor and how much to capital" (Schneider 2011, p.1).

In the literature many mathematical models are developed to prove or disprove the link between inequality and financial crises.

Kumhof and Rancière (Kumhof 2010) presented a dynamic stochastic general equilibrium (DSGE) model of which the main components are two groups: investors and workers. While investors represent the top stratum of the income distribution, workers represent the remainder of it. Both groups derive utility from consumption, investors in addition by wealth. Wages of workers are determined by their bargaining power. As workers' bargaining power decreases, they have to borrow money from investors to maintain their standard of living. As a result, income to debt ratio of workers increases, while the top income group becomes richer. Kumhof and Rancière concluded "... without the prospect of a recovery in the incomes of poor and middle income households over a reasonable time horizon, the inevitable result is that loans keep growing, and therefore so does leverage and the probability of a major crisis that, in the real world, typically also has severe implications for the real economy" (p.22).

Charpe and Kühn (Charpe 2012) developed a similar DSGE model to show how increasing inequality can result in financial crises. The model consists of three main elements: optimizing households, thumb households and firms. In contrast to optimizing households, thumb households do not have access to the financial market and generate income solely by labor. Households and firms try to optimize their utility function. Labor share is determined by bargaining between households and firms. Labor share changes continuously depending on the job market. Based on simulation runs, the relation between consumption, investment,

inflation, unemployment rate, and labor share can be investigated. Rising inequality influences aggregated demand and impacts households' bargaining power. In consequence, financial crises can evolve. According to Charpe and Kühn "[i]t follows that a reduction in worker's bargaining power in a situation of economic recession with low interest rates further depresses economic activity on impact" (p.21f).

Dosi et al. (Dosi 2012) used an agent-based Keynesian model to investigate the influence of income distribution and fiscal policies upon macroeconomic variables like GDP, unemployment rate etc. Agents are producing industry, consumer goods industry, consumer/worker, a bank, a central bank, and the public sector. The model shows some evidence that inequality causes diminishing aggregate demand. The risk of crises increases. They stated: "When the profit margin is very high, redistributive fiscal policies become a necessary condition for long-run growth" (p.17).

Ezuho (Ezuho 2011) investigated how income inequality together with over indebtedness causes financial instability. His model is based on a macro dynamic Goodwin model and includes four variables: the Gini coefficient, private debt, corporate debt, and aggregate demand. Households, firms, and financial institutes are the agents in the model. Rapid income growth of higher income groups is at expense of the lower income groups. While income inequality increases, consumption inequality does not increase in the same pace. Lower income households try to hold their standard of living. This is only possible by reducing saving rate and taking out loans. As a result, debt levels grow while aggregate demand stays high. The model shows a correlation between inequality and financial instability.

The influence of trends and cyclic behavior of private debts is the research topic of Iacoviello (Iacoviello 2005). The main question of his work is: what effects do income shocks and income inequality have upon credit flows? A time discrete model is designed with three agents who differ according to their access to credit market, production function, and income and wealth. The model shows on the one hand that debt levels rise with inequality. On the other hand income inequality and wealth inequality increase while consume stays stable. Iacoviello concluded that "the rise in within-group income inequality can explain at the same time all of the increase in debt, the large widening of wealth inequality and the relative stability of consumption inequality" (p.23).

There is no doubt that the Great Depression in 1929 and the Great Recession starting in 2007/2008, at least for most of the affected countries, were preceded by rising income inequality. This fact is referred by some authors as a proof for the hypothesis that a link between inequality and crises does exist. In the literature a more differentiated view is provided.

Bordo and Meissner (Bordo 2012) investigated whether there exist some empirical evidence that rising inequality results in credit booms and financial crises. Investigating data from 14 countries a causal link could not be found. Rather, credit booms and following crisis are rooted in economic booms or economic revival together with low interest rates.

In a similar study, Atkinson and Morelli (Atkinson 2011) used empirical data from 25 countries in a period of 100 years to answer whether income inequality results in crises, what can be learned from crises, and how public policies can help to prevent economic crises. These data show no empirical evidence that financial crises are always preceded by rising inequality. Indeed, in some past financial crises a rise in income inequality can be identified. However, there also exist examples where crises were preceded by a decrease in income inequality. Atkinson and Morelli "find that economic crises differ a great deal in whether or not they were preceded by rising inequality, and, in any case, where there was such a rise, causality is not easy to establish" (p.49). Albeit, income inequality can promote a financial crisis. Lower income groups need to lend money to hold their standard of living which

disturbs the financial system. Moreover, rising consume of higher income groups could result in a competition forcing lower income groups to take out more and more loans.

Concerning the UK financial crisis, Lucchino and Morelli (Lucchino 2012 )stated that no correlation exists between rising inequality and growth. Consume of higher and lower income groups does not change as fast as income inequality rises. This means, lower income groups have to cut savings and take out loans for financing their consumption. With increasing debt levels financial crises can evolve. They concluded that "[m]echanisms linking inequality, household finances and financial crisis may therefore have been at work in the UK, though more research is warranted to validate this hypothesis" (p.17).

There seems to be no consensus within scientific literature whether rising inequality is one of the main reasons for a financial crisis. Nevertheless, according to empirical and non empirical investigations rising inequality may indeed increase the risk of crises to evolve.

We take these findings as a starting point for our own investigation. In contrast to in macroeconomics widely used DSGE models (see, e.g., Tovar 2008, An 2007) we take a system dynamics approach. As a matter of fact the issues of sustainable fiscal policy and inclusive socio-economic development have been addressed by many studies within the system dynamics community.

Wheat implemented a system dynamics model of the US economy including the foreign sector (Wheat 2007). It consists of six sub-models: production, income distribution, consumption, banking, government, and foreign. The model helps to gain understanding of the behavior of an economy and therefore positively influences the learning curve of students in respect of macroeconomics.

Yamaguchi identified in American monetary system "a reinforcing loop of credit creation called 'Bankers' Greed', and a balancing loop of credit crunch called 'Income Inequality'. Due to these two opposing loops built in the system [...] unstable behaviors of economic growth and inflation rates are inescapably triggered" (Yamaguchi 2012, p. 28). A model by Schade describes the German economic developments in the period 1960 - 2003 based "on a combination of Keynesian and neoclassical elements" (Schade 2005, p. 13). The model "mimics historic data quite good" and delivers "highly significant" results (p. 1).

Quite a few further case studies concerning different national economies can be found (see, e.g., Arenas 2003, Cakravastia 1998, Lektuers 2010, Rego 1987, Rego 1991, Zavrl 2010). Among others Ansah developed a complex model including 17 groups of variables including even health and education "for assessing the impact of government fiscal policy on socio-economic development and fiscal sustainability" (Ansah 2010, p. 83). The author claimed that fiscal sustainability "can only be achieved by considering the complex relationships between the social sector, the economic sector and the public sector" (p. 1). The results of his policy simulation, as he summarized, indicate "that an expansionary fiscal policy is the preferred policy when one needs to increase and enhance socio-economic development. On fiscal sustainability, the simulation result concludes that contractionary fiscal policy is the best policy to significantly reduce the public debt burden in Ghana" (p. 83).

Limiting and reducing debt while enhancing socio-economic development, this seems to be the challenge for every national economy.

### **3. A system dynamics model**

The system dynamics model which we present in this section is focused on the relations and driving forces between gross domestic product (GDP), consumer debt which includes the public debt, and inequality within a national economy. It is kept to be a "small model"

(Forrester 1991, Ghaffarzadegan 2011) from which we expect to gain important insights into possible existence of correlations between inequality and debt crises.

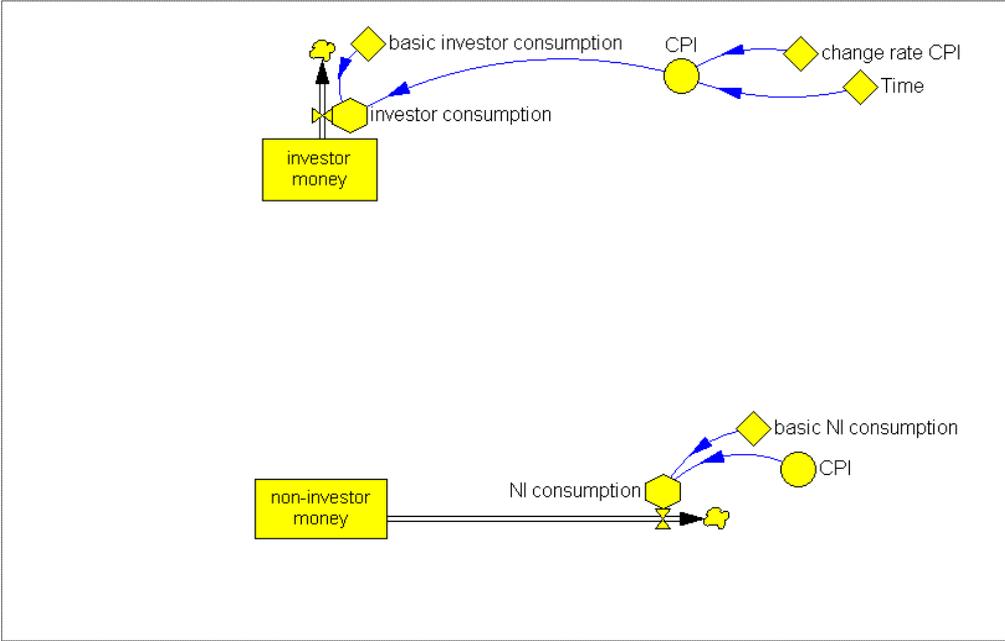


Figure 1: Two groups: investors and workers or non-investors

The starting point of our modeling includes two groups: investors and non-investors (NI), as shown in Figure 1. These two groups allow to model income inequality in an economy clearly. One key difference between these two groups is that the members of the first group never need to adjust their consumption level because of lack of money while the members of the second group have to do that if necessary. Focusing on investors and non-investors resembles the work by Kumhof and Rancière (Kumhof 2010a).

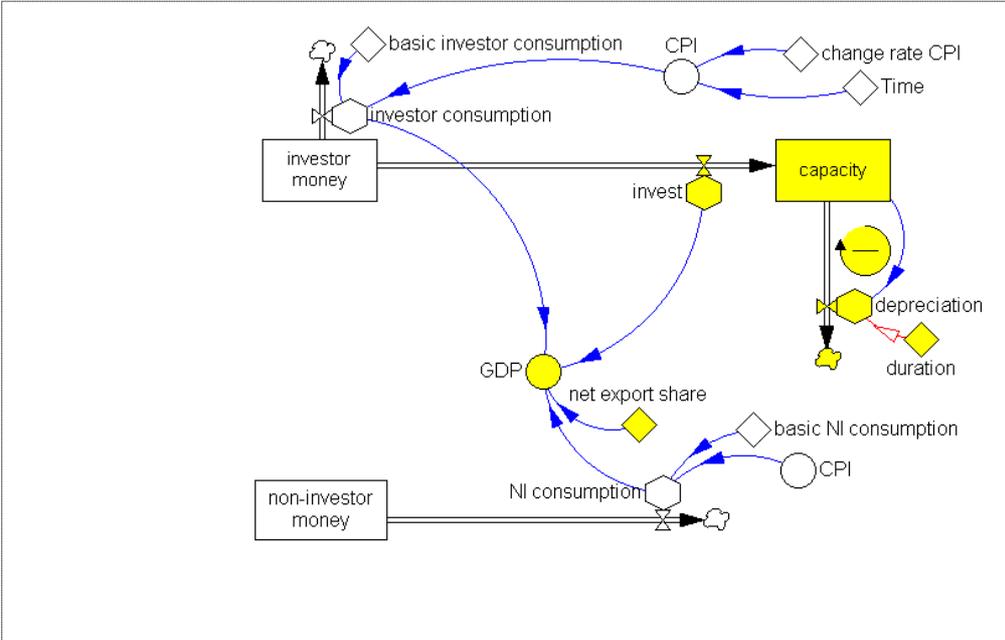


Figure 2: GDP as the sum of consumption, investment and net export

Investors and non-investors spend their money (investor money respectively non-investor money) for their consumption of products and services (investor

consumption and NI consumption). Both groups have certain basic consumption level (basic investor consumption, basic NI consumption) which may change over time because of the changing consumer price index (CPI) which is a simple function of the annual change rate CPI and Time.

Investors have to invest more or less into production and service capacity continuously (Figure 2). Otherwise the capacity would diminish over time (see, e.g., Sterman 2000). GDP is given by the sum of consumption and investment together with net export which is expressed by net export share of GDP in our model. The capital depreciation is characterized by the parameter duration and a simple balancing loop. In contrast to many existing models (see, e.g., Arenas 2003, John 2010, Moscardini 1998, Schade 2005, Zavrl 2010) but in accordance with (Radiant 2004) and (Wheat 2007) we do not treat GDP as a stock, but mainly as a sum of several flows.

We consider the government or more precisely the national and regional administrative bodies as non-investors. Their spending is thus included in non-investors' consumption.

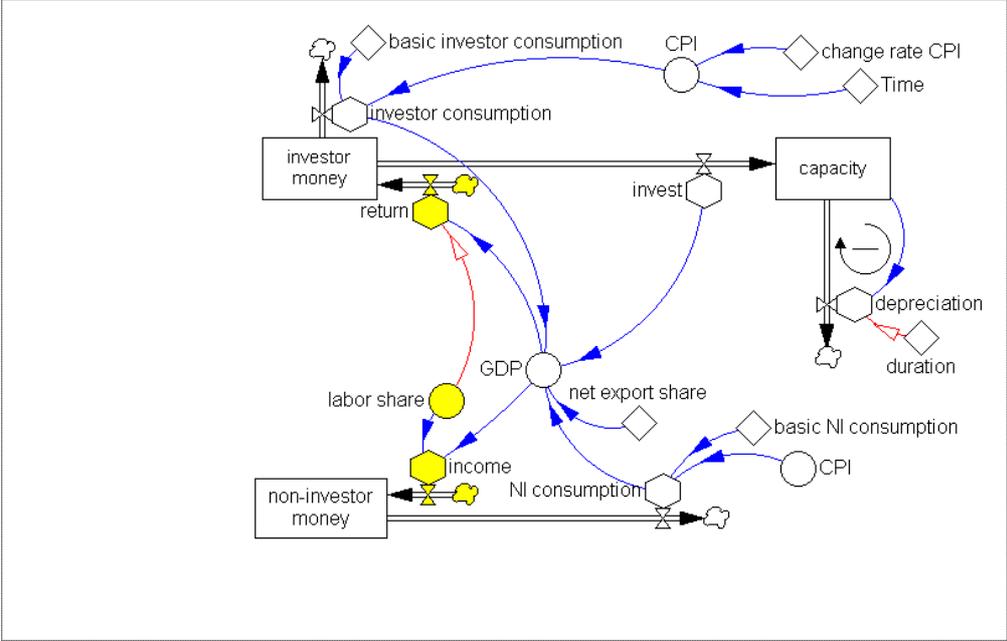


Figure 3: Labor share

In our model, GDP in total is shared between non-investors' income which includes the tax income of public households, and investors' return (see Schneider 2011, p.1), as shown in Figure 3. The share of non-investitive income of GDP is expressed by Labor share which ranges between 0.44 and 0.80 with a mean between 0.54 and 0.67 in the EU15 countries in the period 1970-2004 (Arpaia 2009).

Increasing capacity may drive increasing consumption. In our model the effect of the supply-side economic effects can be parameterized by the both lookup functions investor consumption add-on and NI consumption add-on. The only input variable of these both functions is the ratio of capacity to its initial value capacity start (Figure 4).

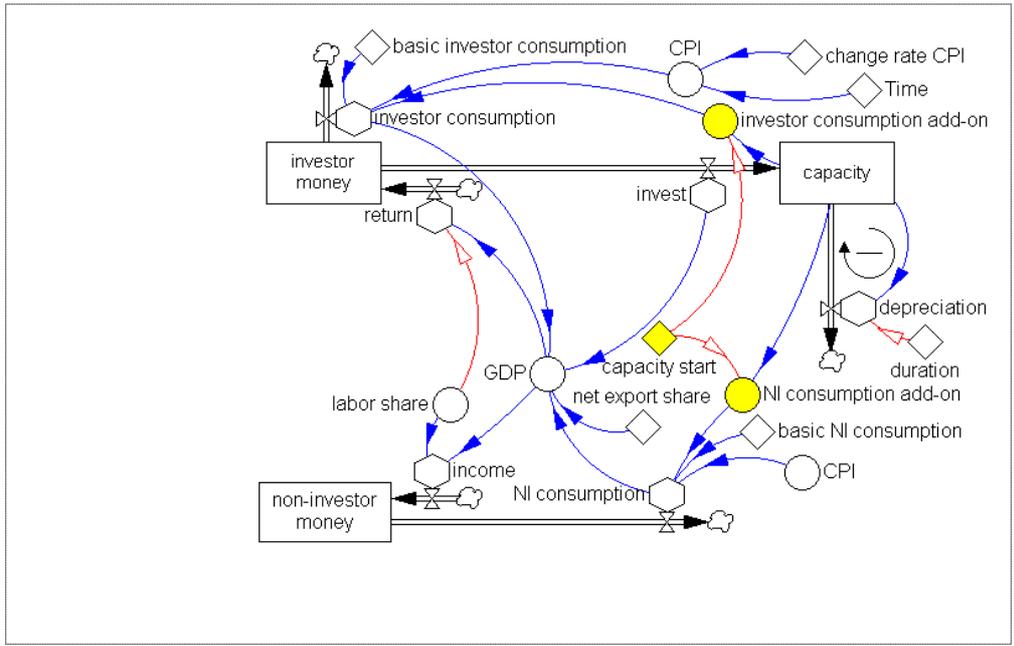


Figure 4: Capacity driven consumption

Investors reinvest a certain share (reinvest share) of their earned money (return last year) in capacity seeking to increase profit and to counter capacity depreciation (Figure 5). As to now, three reinforcement loops can be identified. They represent the drivers of economic growth. Investing money increases capacity. GDP is per definition positively influenced by investment and by consumption. A higher level of the latter may be induced by higher capacity (see, e.g., Lucas 1990, Ireland 1994). Interestingly, non-investors' consumption is a part of these reinforcement loops but their income is not. On the contrary: a higher income of non-investors means a lower return at given GDP and thus a lower economic growth.

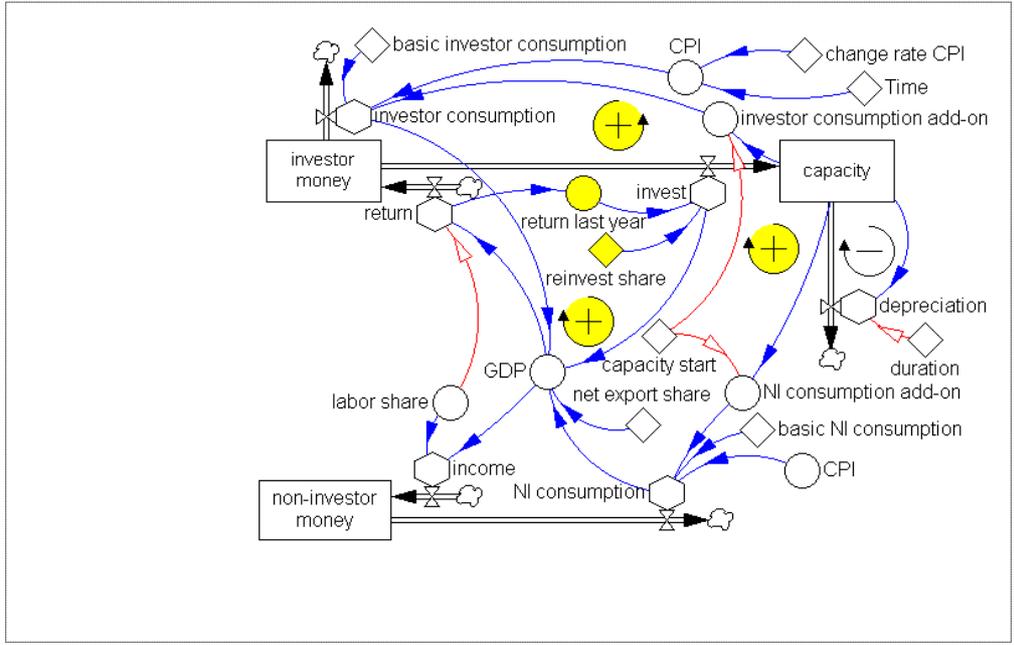


Figure 5: Reinvestment

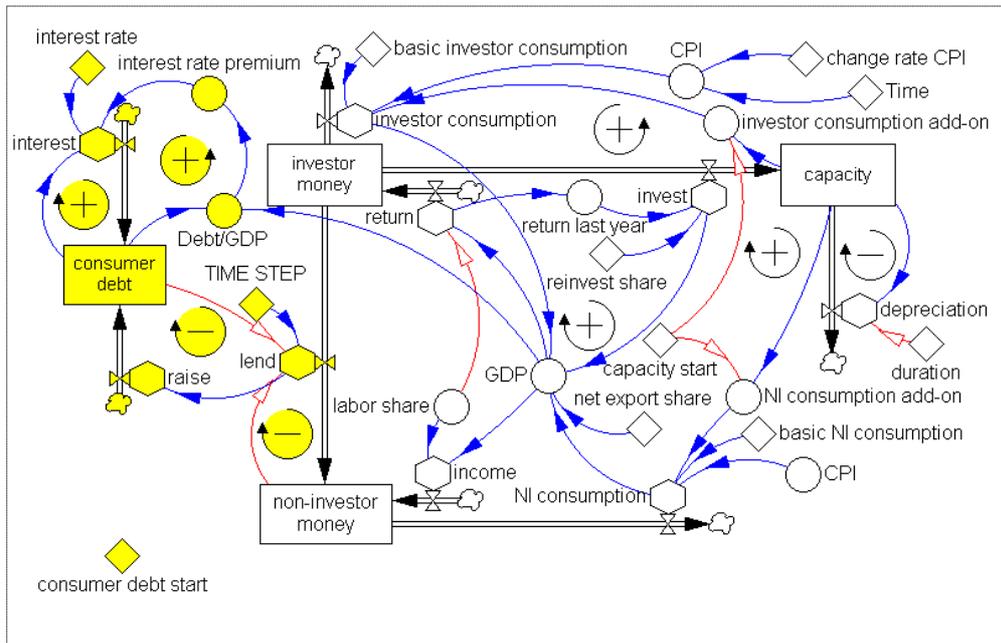


Figure 6: Consumer debt

Hence, an ostensibly smart idea to boost economic growth is to reduce non-investors' income. Once non-investors run out of money, investors lend them simply the necessary amount to keep their consumption and thus the economic growth going. In other words the non-investors have to raise the amount of consumer debt to keep their living standard. In our model the flows lend and raise are considered bi-directionally, i. e. non-investors make an effort in each Time Step to reduce consumer debt if they can, as embodied by the two balancing loops. Using consumer debt start different scenarios can be simulated (Figure 6).

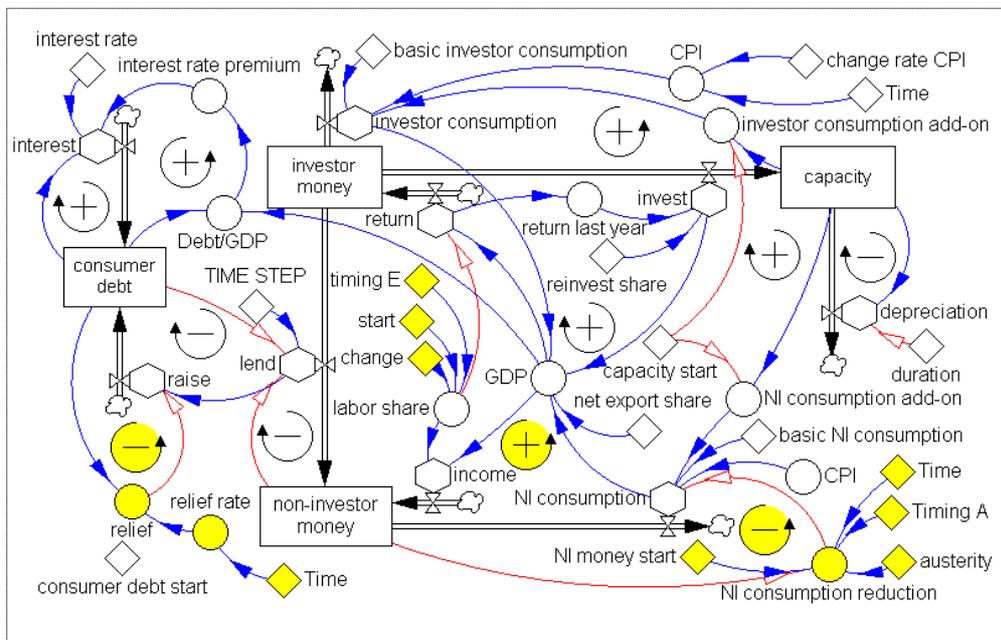


Figure 7: Three options to combat indebtedness

However, nobody would overlook that it is nothing else but this structure which brings many national economies into indebtedness (see Kumhof 2010), among others, because of the two reinforcement loops. Non-investors have never a chance to pay back the loans including

interest if the situation does not change fundamentally. In addition, interest rate is often determined by debt/GDP ratio of which a high value means a higher effective interest rate because of a possible interest rate premium.

According to our model there are three ways out of debt in a national economy, as shown in Figure 7. Besides the - from the point of view of modeling - trivial possibility of debt relief, modeled using relief rate as a function of Time, we implemented the both options "labor share adjustment" and "austerity" in our model to get more insights into the dynamic effects and the difference between these both controversy options:

- The initial value of labor share is given by start. At the time timing E labor share changes about the amount change. A labor share adjustment takes place.
- Starting at the time timing A the parameter austerity defines how strong the non-investors' consumption should be reduced when they are going to run out of money (measured through the ratio non-investor money to NI money start). The two new balancing loops do not only reduce non-investors' consumption but also the economic development.

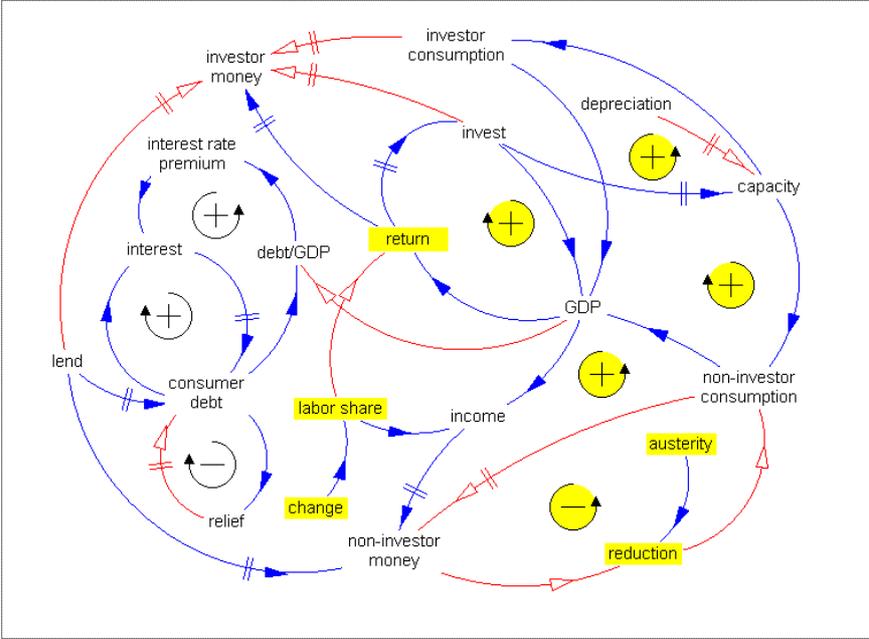


Figure 8: A causal loop diagram showing the essential links between consumer debt, economic development and income inequality

The essential links between consumer debt, economic development and income inequality are shown in Figure 8 as a causal loop diagram. It becomes apparently that both an increase of labor share and a policy of austerity have negative impacts on the economic development. A quantitative comparison between the both options is thus necessary.

**4. Results**

Using the system dynamics model described in Section 3 different options for a national economy to achieve inclusive growth and sustainable finance can be simulated computationally.

### 4.1 Inclusive growth as a prerequisite for achieving sustainable finance

In the first group of simulation runs different fix values of labor share  $\in [0.50, 0.62]$  are used to demonstrate possible range of labor share values which make an inclusive growth and sustainable finance possible. It becomes apparent in Figure 9 that the speed of increasing consumer debt in a national economy depends on the value of labor share. The lower the labor share the higher the debt level is to be expected. For values not less than 0.59 of labor share a debt-free growth can be achieved. Inclusive growth is a prerequisite for sustainable finance.

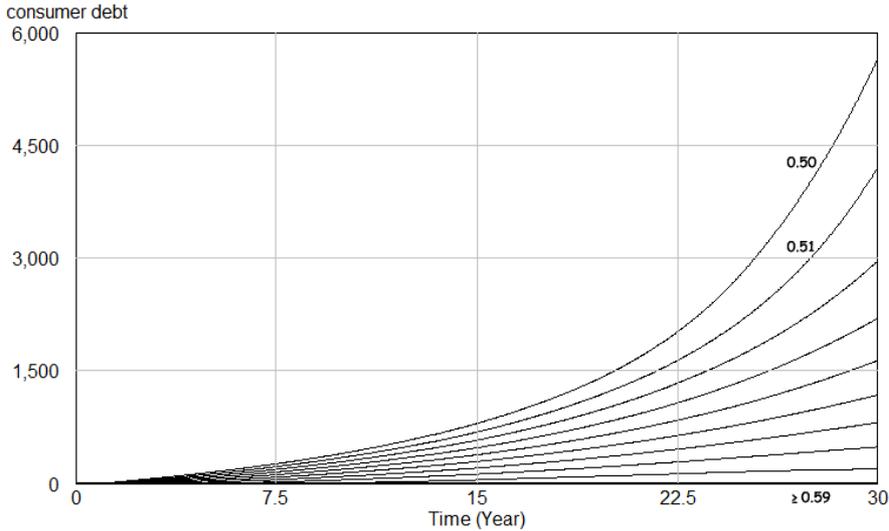


Figure 9: Consumer debt developments at different values of labor share

On the other hand, as shown in Figure 10, the lower the labor share the higher the economic growth is to be expected. Combined with the results shown in Figure 9 we see a real possibility to achieve debt financed growth through lowering labor share. This represents a challenge which not only the politics but the entire society is facing. Because of the immediate attraction and the long-term damage of debt-financed growth a constitutional anchoring of debt ceiling seems to be the only choice to prevent indebtedness of public households.

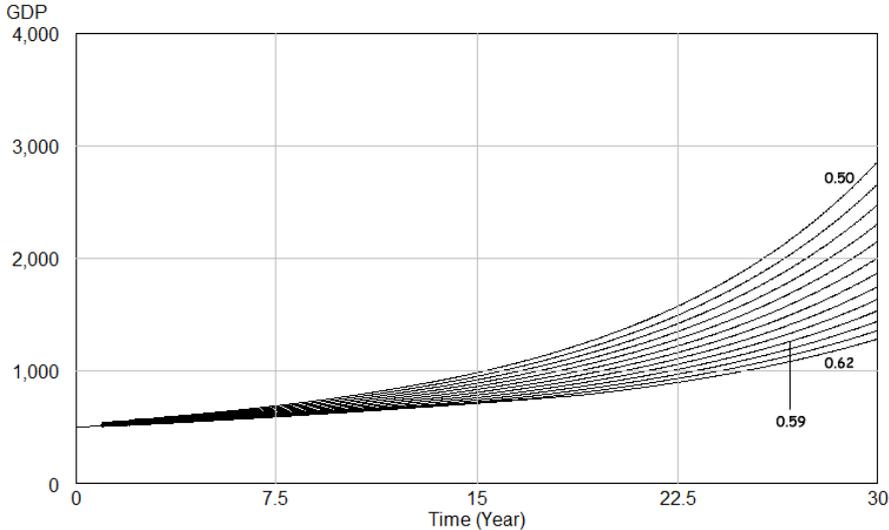


Figure 10: GDP at different values of labor share

Figure 11 shows the development of debt to GDP ratio. A lower value of labor share than 0.52 leads to a debt to GDP ratio of higher than 100% within 30 years if both public and private consumer households have unlimited access to credit market. A constant annual rate of 6% is assumed in all our simulation runs. We do not even have considered a possible increasing interest rate because of a possible interest rate premium.

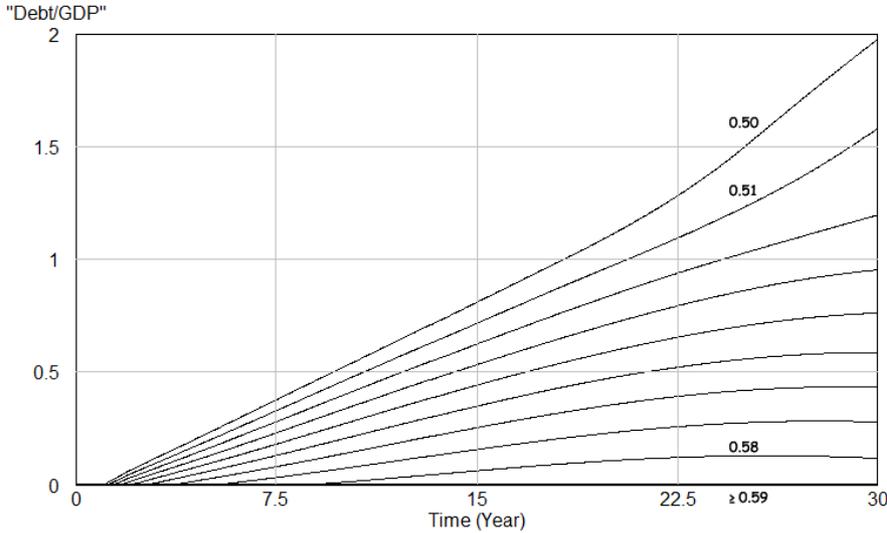


Figure 11: Debt to GDP ratio at different values of labor share

During investors' total assets consisting of their cash assets, capital invested in capacity and consumer debt continue to increase their cash assets do not increase anymore from exactly the moment when the non-investors begin to raise debt. As shown by the simulation results and thoroughly expected, a higher labor share than 0.59 leads to decreasing investors' cash assets, as shown in Figure 12.

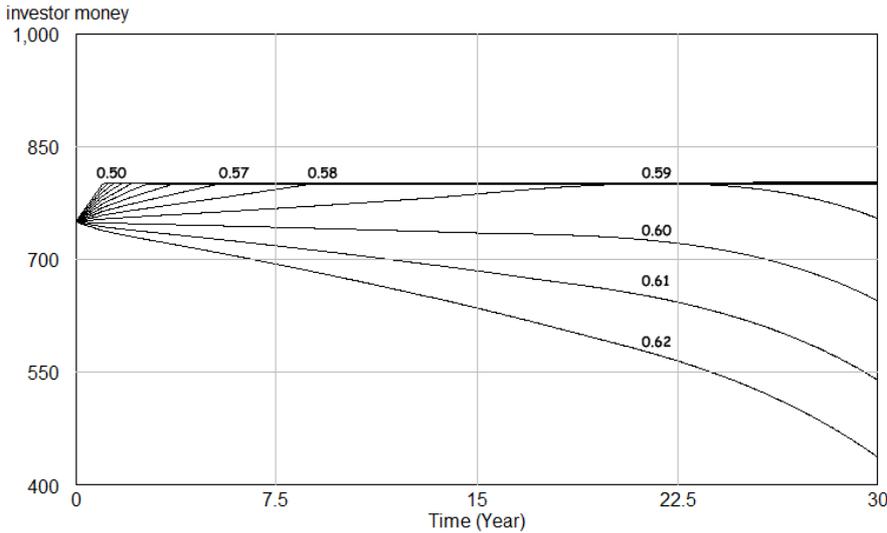


Figure 12: Investor money at different values of labor share

These simulated results seem to explain why Bordo and Meissner found no further evidence for the link between income concentration and financial crises than credit booms before the crises (see Bordo 2012). As a matter of fact, it is not necessary to have a decreasing labor share but a low labor share to induce an exponential growth of consumer debt simply because

the *delayed* but exponential growth is the nature of a debt and interest structure. In other words, understanding stock-and-flow dynamics is a key to understand and thus to prevent or overcome debt crises.

### 4.2 The effect of foreign trade

As expected, a trade surplus or deficit has some impact on the development of GDP. As simulated based on our model, the difference between the case of surplus (black) and the one of deficit (red) of 1% of GDP is rather small (Figure 13).

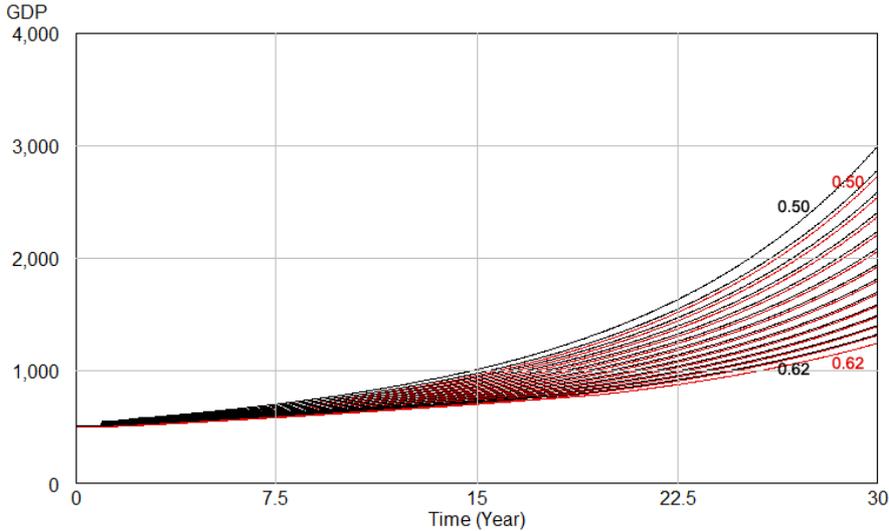


Figure 13: GDP at different values of labor share and foreign trade balance

Coming to the consideration of debt, on the other hand, we realize that the difference between a surplus or a deficit may be significant. As shown in Figure 14, the debt to GDP ratio grows significantly faster when there is a 1% foreign trade deficit (red) compared to the case that there is a 1% surplus (black).

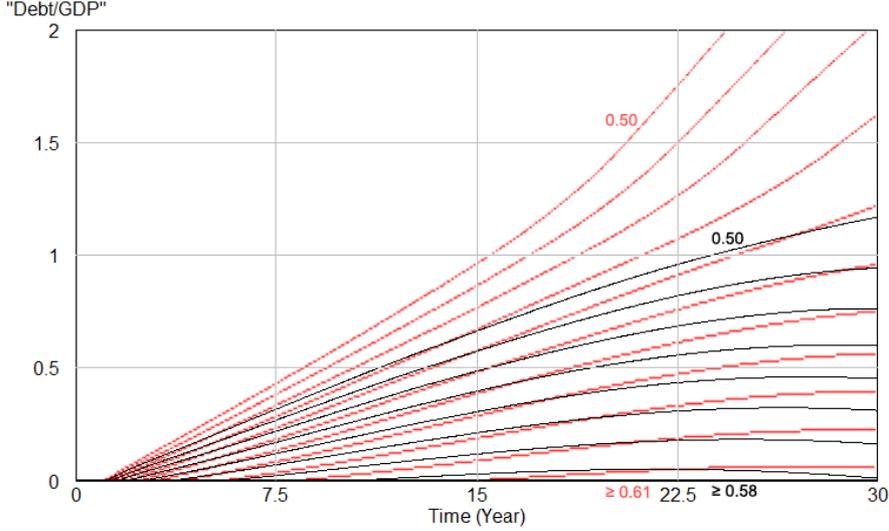


Figure 14: Debt to GDP ratio at different values of labor share and foreign trade balance

Remarkably, the threshold value of a debt-free growth may be also shifted to 0.61 (1% deficit) or 0.58 (1% surplus) under the influences of the foreign trade balance. In other words: the lower the competitiveness of a national economy, the higher equality has to be achieved. Otherwise it is exposed to a higher risk of indebtedness.

### 4.3 Keynesian vs supply-side economics

In a further group of simulation runs we examine if the supply-side economics effects have any impact to the results presented in Section 4.1.

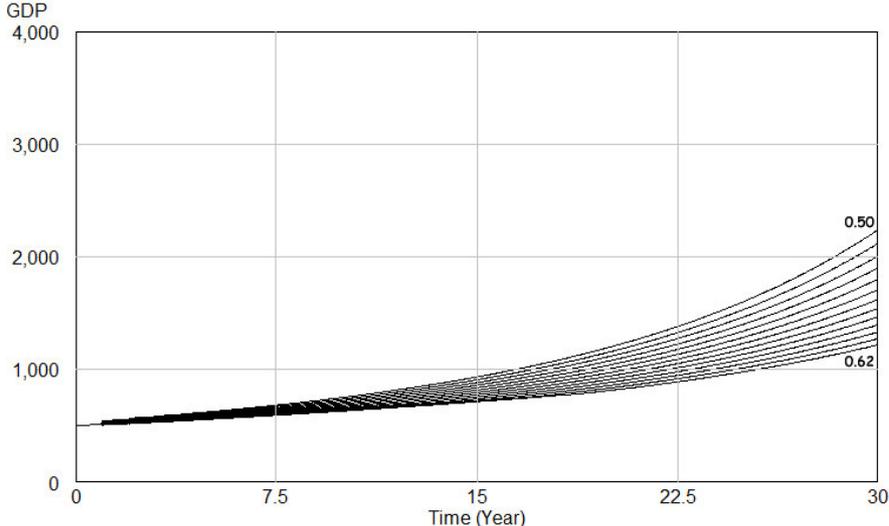


Figure 15: GDP at different values of labor share and reduced supply-side effects

Figure 15 shows our simulated economic growth when reducing the both effects labor consumption add-on and investor consumption add-on about 20% while other parameters remain their values. Compared to Figure 9 we see a significant reduction of speed of the economic growth, as expected.

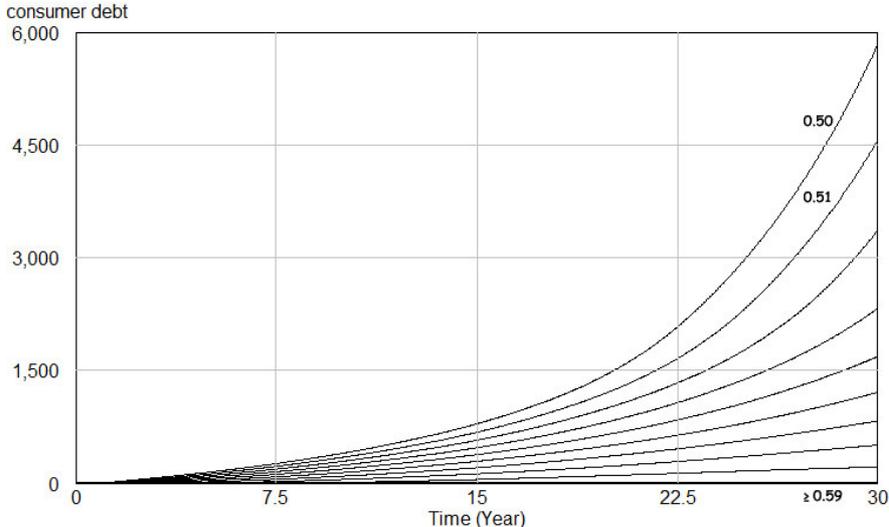


Figure 16: Consumer debt development at different values of labor share and reduced supply-side effects

At the same time the development of consumer debt seems to be not influenced by the reduction of supply-side effects. Most importantly, the threshold value of labor share of 0.59 for a financial sustainable growth is not changed (Figure 16).

**4.4 Increasing labor share as a better option than austerity to achieve rebalancing**

In this section we compare two options of policy changes. All parameters have the same initial values as in Section 4.1 but labor share has a value of 0.5 which leads to increasing debt level. At a certain moment a policy change takes place towards more income equality – the value of labor share changes to 0.7 immediately – or a policy of austerity which means that non-investors' consumption is reduced by up to 2/3 to mitigate the consumer debt.

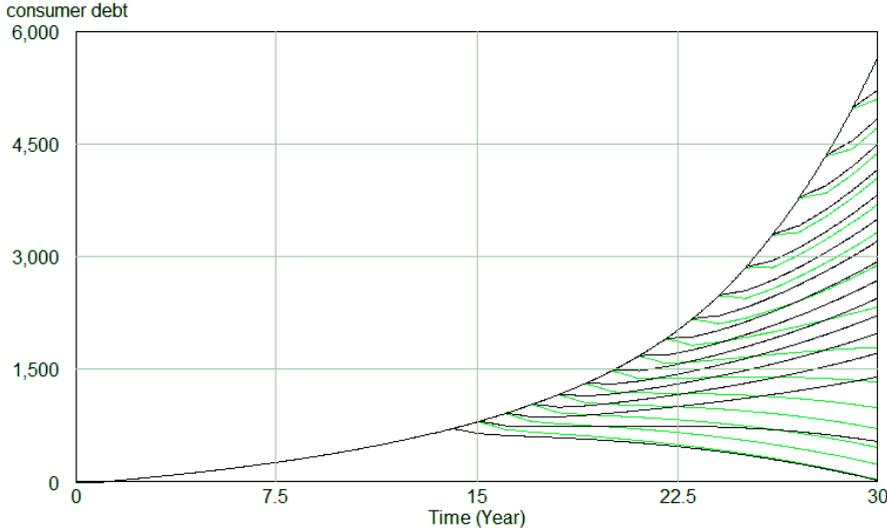


Figure 17: Consumer debt developments under two different options of policy change

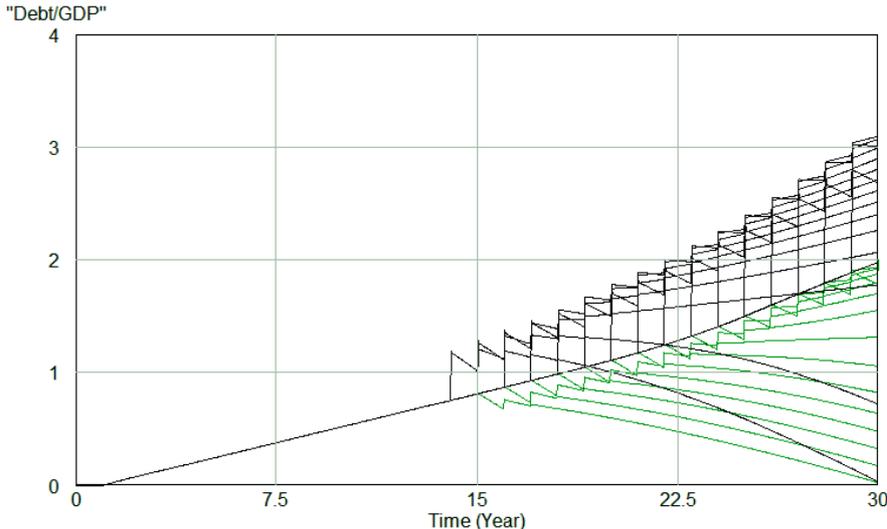
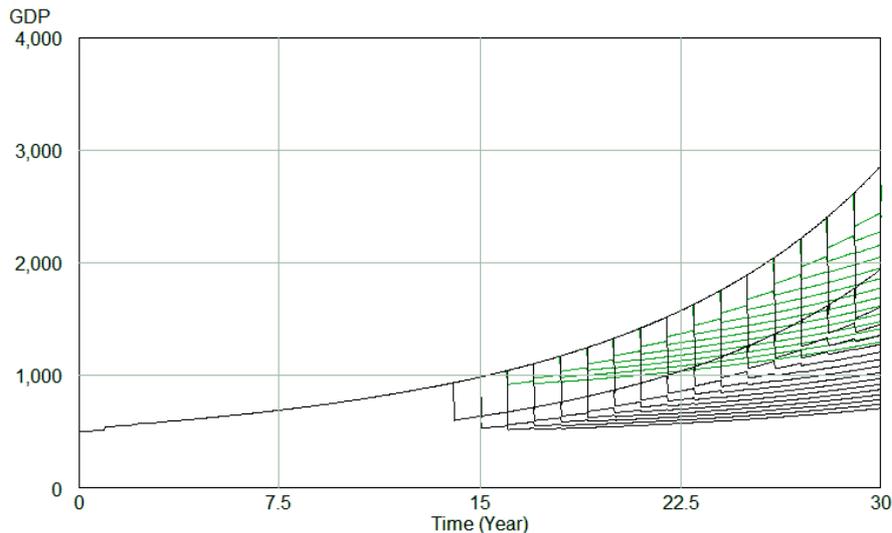


Figure 18: Debt to GDP ratio under two different political options

Our simulated results show that both political options - "austerity" (black) and "equality" (green) can be implemented to reduce debt level to zero in the 30<sup>th</sup> year if they are started in

time (Figure 17). For "austerity" this point of time is the 14<sup>th</sup> year and for "equality" the 15<sup>th</sup> year, the debt to GDP ratio is 75% and 81%, respectively (Figure 18).

However, there is a point of no return at the 17<sup>th</sup> year or a debt to GDP ratio of 92% regarding the option "austerity" - afterwards the consumer debt will increase despite the hardness of the austerity policy. The option "equality" leaves the policy makers more time till the 20<sup>th</sup> year or a debt to GDP ratio of 110%. The political option towards more equality (green) reduces the debt level from the very beginning and is more effective compared with the policy of austerity (black) which leads immediately to an even higher debt to GDP ratio and leaves only little time for the implementation of such a policy.



*Figure 19: GDP under two different political options*

As feared, both policy changing options cause a economic down turn which is in the case of "equality" (green) smaller than in the case of "austerity" (black), as shown in Figure 19.

It becomes apparently that achieving more income equality is a far better method meeting the challenge of the debt crisis. Inclusive growth can be seen as a prerequisite of sustainable finance.

## **5. Conclusion**

Our literature review (Section 2) has shown no uniform pattern concerning the question whether raising income inequality causes financial disruptions or not. Answering this question is essential for implementing effective measures not only to master the ongoing financial crisis but also to prevent forthcoming ones.

We have developed a system dynamics model which shows clearly the dynamic interdependencies between income inequality, debt levels and economic growth (Section 3). With full intentions our model is held as simple as possible. Nevertheless, it contains the essential elements of a national economy: investors and non-investitive consumers, a market for products and services, and a financial sector. While focusing on the single national economy, exports and imports are considered as well in our model. Triggers allow to simulate policy changes in a flexible way. Thereby, the middle to long term impact of different policies on debt levels and GDP can be evaluated clearly.

Following the well known methodology of system dynamics and in contrast to widely used DSGE models our model focuses on the system immanent feedback structures while taking

into account possible changes of endogenous and exogenous parameters. Our model simulations show that it is not necessary to have a decreasing labor share but a low labor share to induce an exponential growth of consumer debt simply because the delayed but exponential growth is the nature of a debt and interest structure. In other words, understanding stock-and-flow dynamics is a key to understand and thus to prevent or overcome debt crises (Section 4.1). A national economy with low competitiveness has to establish a high equality of income since it is exposed to a high risk of indebtedness (Section 4.2).

Compared to austerity, achieving more income equality seems to be a better method to limit and reduce debt while enhancing economic growth, as shown in our model simulations (Section 4.4). From our point of view it is important for all policy makers – supranational, national and regional administrations, central banks, representatives of employers' organizations and trade unions – not to focus solely on reducing public debts by following a strict course of budget consolidation. A revised (re)distribution policy could be a more promising way to reduce debt levels and to push growth simultaneously. Sustainable growth and limited debts seem to be absolutely essential in order to prevent financial crises.

We intend to expand our aggregated macroeconomic model in the next steps. One extension concerns the public sector. By explicitly implementing the government as a third consumer, we should get some important insight about the relation between public and private debts. Refining the sub-model of the financial sector is another aspect. Thus, our understanding of the role of the banks before and in financial crises should be deepened. Furthermore, we are going to combine system dynamics with agent-based modeling to describe more detailed the behavior of different customers or the competition between several national economies. These may contribute to understand the mechanisms behind financial crises and the influence of income inequality in a global economy.

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