Inclusive Green Growth and Sustainable Finance Through Ecotax - a System Dynamics Model

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Abstract

This paper examines the possibility of combining the efforts for socio-economic improvement and environment protection through an ecotax. Based on a previous model on sustainable finance of economic growth through several socio-economic options, the new model extension and simulations demonstrate that both the rate of the ecotax and the use of the ecotax revenue matter. A properly imposed ecotax may contribute to the achievement of both inclusive green growth and sustainable finance.

Keywords: ecotax, inclusive growth, indebtedness, sustainable growth

1. Introduction

Ruinous exploitation leads to depletion of non-renewable nature resources, environmental pressure and indebtedness of national economies. Addressing these issues with one single policy may help to form a successful coalition facilitating political changes towards a sustainable system on a national or multi-national level.

Based on a previous model on sustainable finance of economic growth through several socio-economic options (Block 2013) this paper examines the possibility of combining the efforts for socio-economic improvement and environmental protection through an ecotax. The new model extension and simulation demonstrate that both the rate of the ecotax and how ecotax revenues are used do matter. A properly imposed ecotax may contribute to environmental protection while facilitating economic growth in the long run. Simulation runs reveal that an ecotax based policy can result in inclusive green growth and sustainable finance if the right balance between green investments and income improvement is found.

In the following Section 2, we first introduce some related research works. Section 3 presents the extended model. Using this model some scenarios are simulated and presented in Section 4. Section 5 concludes this paper.

2. Background

Climate change and other environmental issues are among the most critical challenges we are facing in the modern world. The strategy seeking well-being through an ever increasing GDP has already met its limits - the limits to growth (Meadows 1972). Well-being, health, and life expectancy may decrease in a growing economy. Particularly, the dramatic air pollution problems in China's mega cities clearly illustrate the negative effects of GDP growth at the cost of the environment (Chan 2008). Furthermore, increasing production and consumption, per definition a prerequisite for GDP growth, often results in an exploitation of non-renewable resources.

Governments all over the world are forced to implement policies to reduce ecological pressure. Modern technological and systematic innovations may drive the markets into the right

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direction. The overall aim is to counter climate change and other environmental pressures, such as increasing pollution or irreversible biodiversity loss, without putting economic growth at risk. Green growth is supposed to break the established link between the „environmental bads“ and the „economic goods“ (OECD 2002).

The United States government for example provides a US$ 7,500 tax credit to subsidize the production of each electric vehicle in order to both reduce carbon emission and develop an electric vehicle supply chain in the United States (Canis 2013). Norway implemented one of the highest carbon taxes per ton CO_2 in the world to fulfill the Kyoto Protocol (Bruvoll 2002). Dramatically increased fossil fuel prices directly lead to new energy efficient technologies as well as carbon mitigation technologies both in households and in industry production processes. Despite some fossil fuel intensive industries the ratio of carbon dioxide emissions to GDP decreased by 12%. In 2012 Germany initiated a program for the sustainable use and conservation of natural resources (BMUB 2012). The goal of this ambitious program is to foster Germany's economy while simultaneously reducing environmental pollution. On the one hand, the extraction and use of natural resources are to be made more sustainable. On the other hand, stable employment and social cohesion must be guaranteed.

Meanwhile, stable employment and social cohesion is endangered by indebtedness in many national economies. In 2013 the estimated size of the global debt and securities market has reached incredible $100 trillion (Drehmann 2014). Many research works have shown that indebtedness is mainly caused by income inequality (see, e.g., Kumhof 2010, Charpe 2012). A sustainable policy has to be aimed at an inclusive green growth (OECD 2012). Such a policy-mix may include tax break and subsidies to direct private investment toward green technology as well as taxing undesirable behavior. The latter is called ecological or environmental taxation or short ecotax.

The introduction of an ecotax can involve significant political economy challenges (OECD 2010). For instance, taxes on certain energy sources like carbon fuel applies to all residents and can be a burden for low-income households (see, e.g., Bach 2001). It is up to the governments to secure the social system by not only carefully considering the design and coverage of ecotaxes but also guaranteeing a useful usage of the generated revenues. The OECD proposes to handle revenues from ecotaxes as general government revenues that should be used for example to reduce other taxes or debts (OECD 2011). Discussing the rate of the ecotax and its usage is the aim of this paper.

3. A system dynamics model

In a previous paper (Block 2013) we focused on the relations and driving forces between gross domestic product (GDP), consumer debt – including public debt, and income inequality within a national economy. In this section the updated and extended model starts likewise with a substructure describing the `GDP`, which is given by the sum of `investor consumption`, `non-investor consumption` and `invest total` together with net export which is expressed by `net export share` of GDP. A consumer price index (`CPI`) is included to reflect the price change over `time` (Figure 1). Notice that both private and public households are summarized as non-investors.

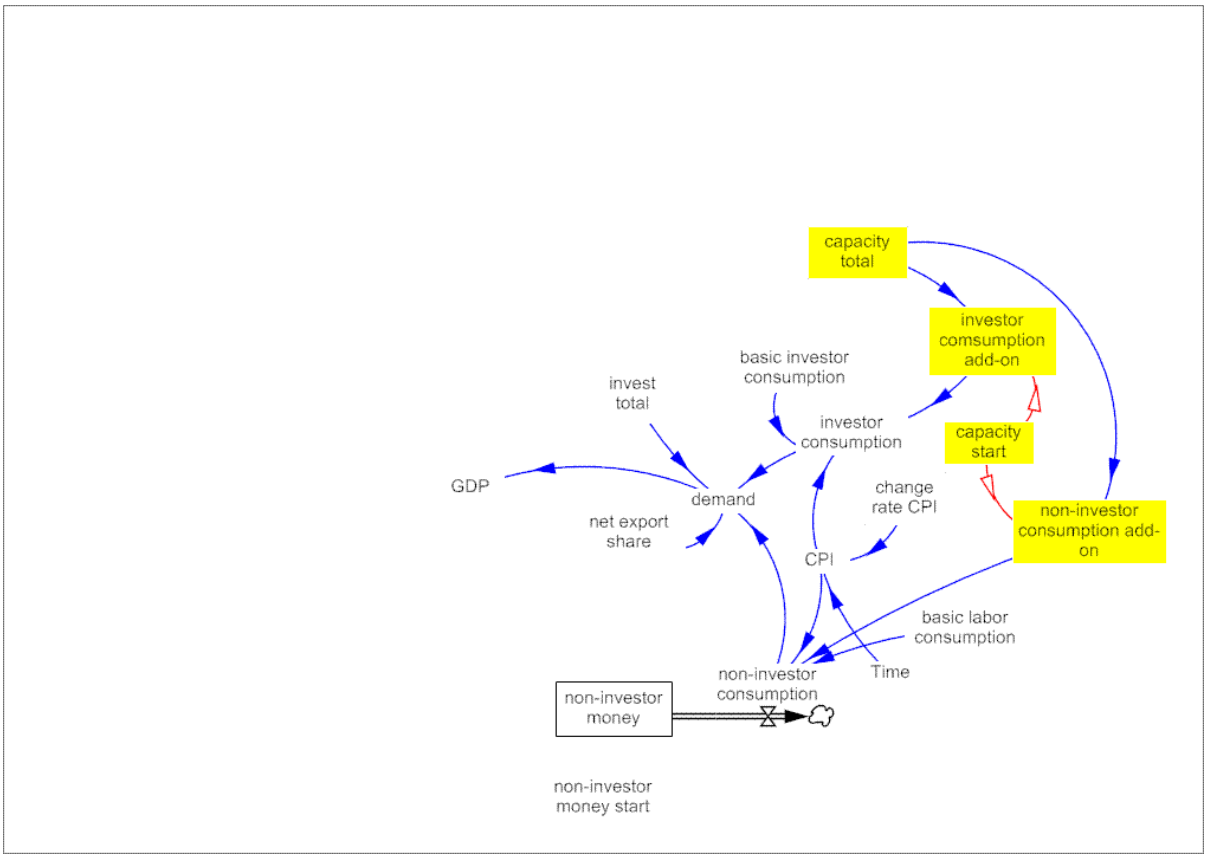


Figure 1: GDP and factors influencing consumption

A higher production, service and innovation capacity (Johnson 2005) may trigger a higher investor and non-investor consumption.

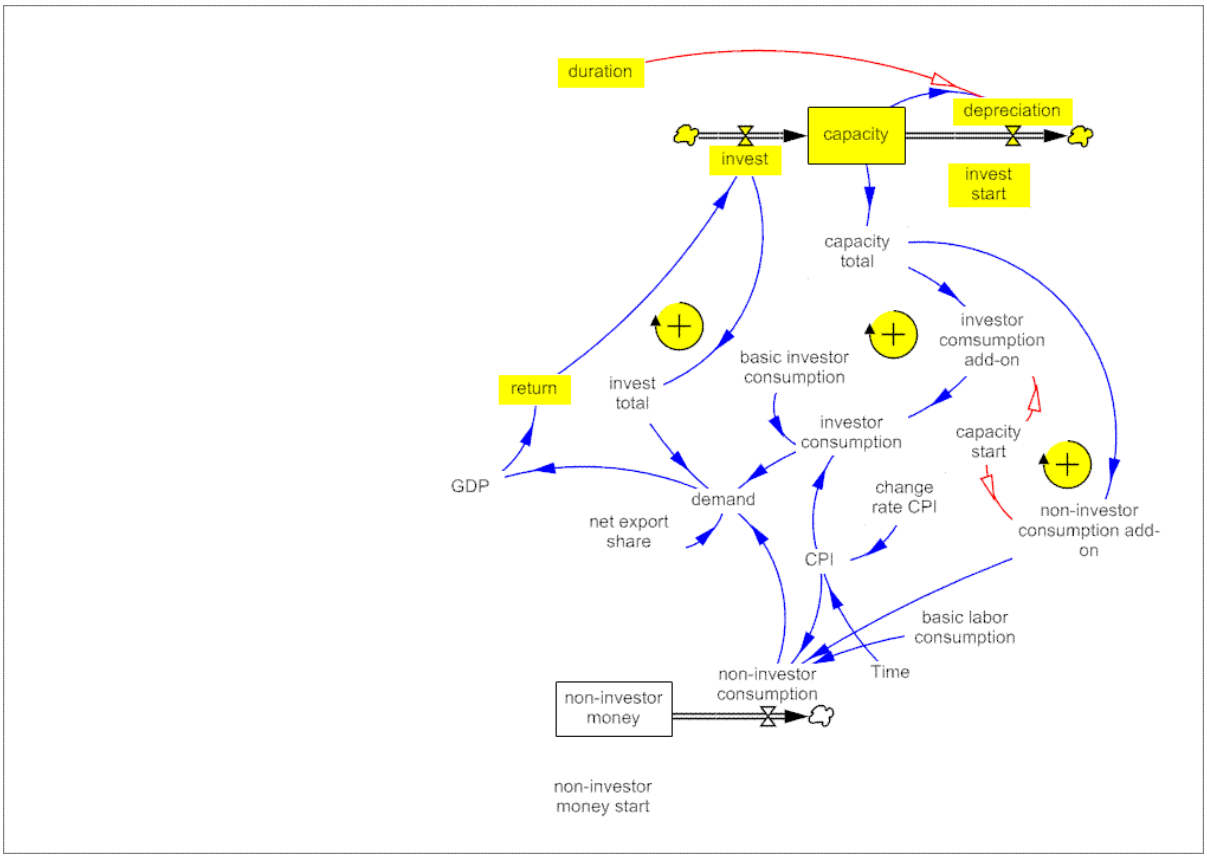


Figure 2: Conventional capacity

The `capacity` outflow or the capital `depreciation` is characterized by the parameter `duration` (Figure 2). To counteract the depreciation or even to raise capacity one has to `invest` or to activate the inflow of the capacity. Notice that it is the (expected) `return` which drives the investment. Three reinforcement loops are identified which are drivers of growth.

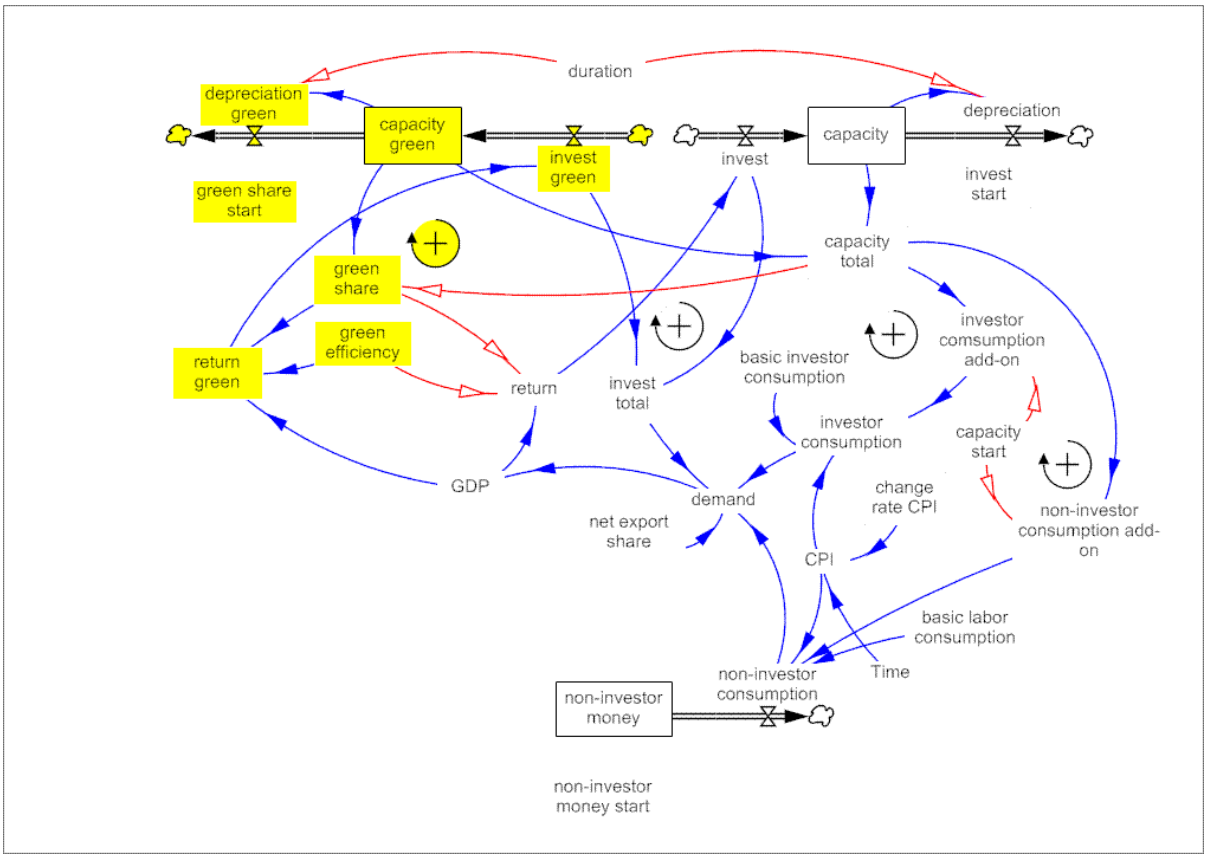


Figure 3: Green capacity

In this model we differentiate between the conventional capacity and the `capacity green` (Figure 3). In analogy to capacity, green capacity is subject to `depreciation green`. Green capacity depicts the results of all successful efforts to reduce usage of non-renewable resources in all production, service and innovation processes. As an ideal model assumption green capacity does not consume non-renewable resource at all. A real national economy is depicted by a combination of a certain share of green capacity and conventional capacity consuming fully non-renewable resources (see, e.g., Hu 2010). Greening an economy means to steadily increase the share of green capacity (`green share`). Notice that an additional reinforcement loop can be identified which is the driver of green economy. Since the returns from the conventional and the green capacity may differ, a parameter for sensitivity analysis – `green efficiency` – is introduced.

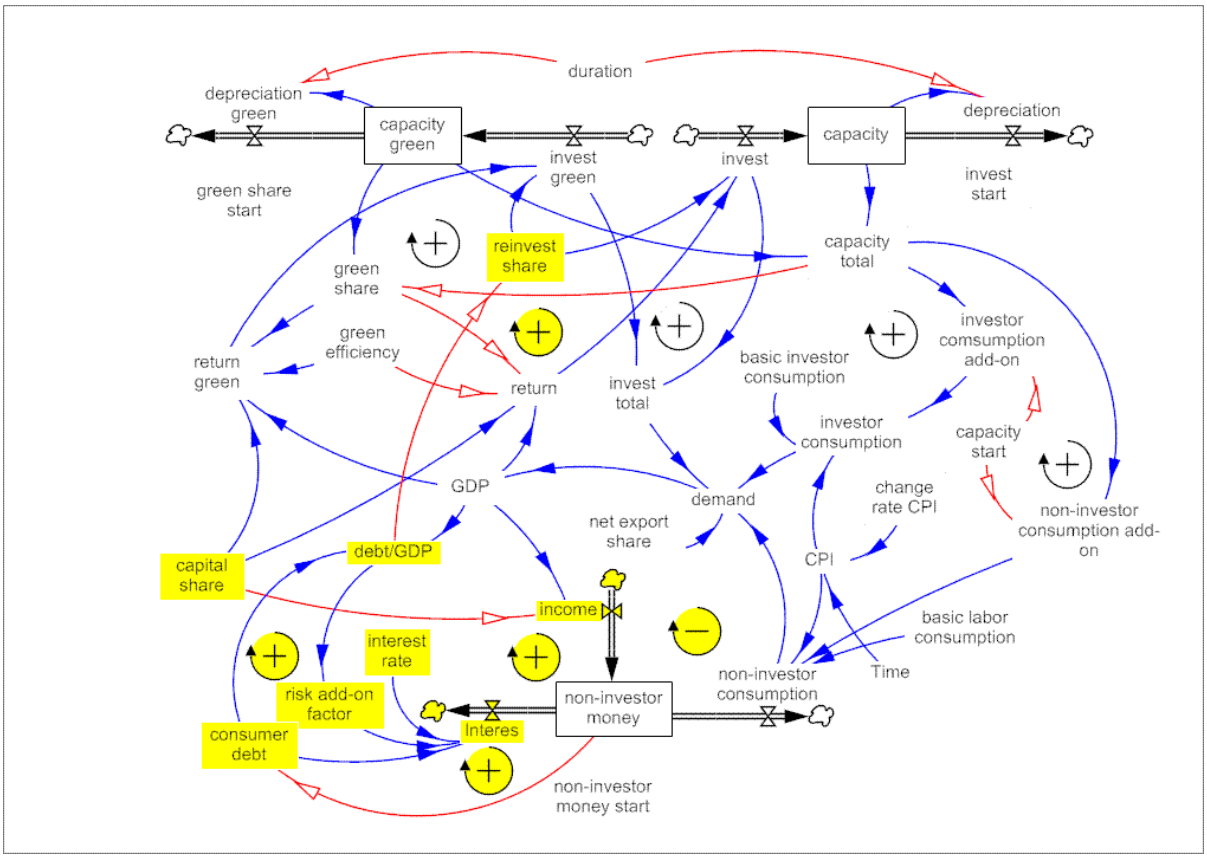


Figure 4: Consumer debt

Non-investors' or households' income consists of work `income` and – in the case of public household – of taxation. The higher the capital share, the lower the income of households. Under increasing income inequality households with their `non-investor money` can often not afford all products and services offered by the existing capacity. A short-termed and short-sighted way to keep economy growing is to provide easy access to consumer credits. Not a small fraction of non-investors fund or are forced to fund their consumption by taking up loans (Figure 4). Repaying loans further reduces non-investor money. The repayment includes the `interest rates` for the loans. Financial institutions usually determine interest rates by calculating loan default risks so that a `risk add-on factor` to the interest rate has to be taken into account. In the long run a high and increasing `Debt/GDP` ratio will reduce `reinvest share` and cause an economic down turn.

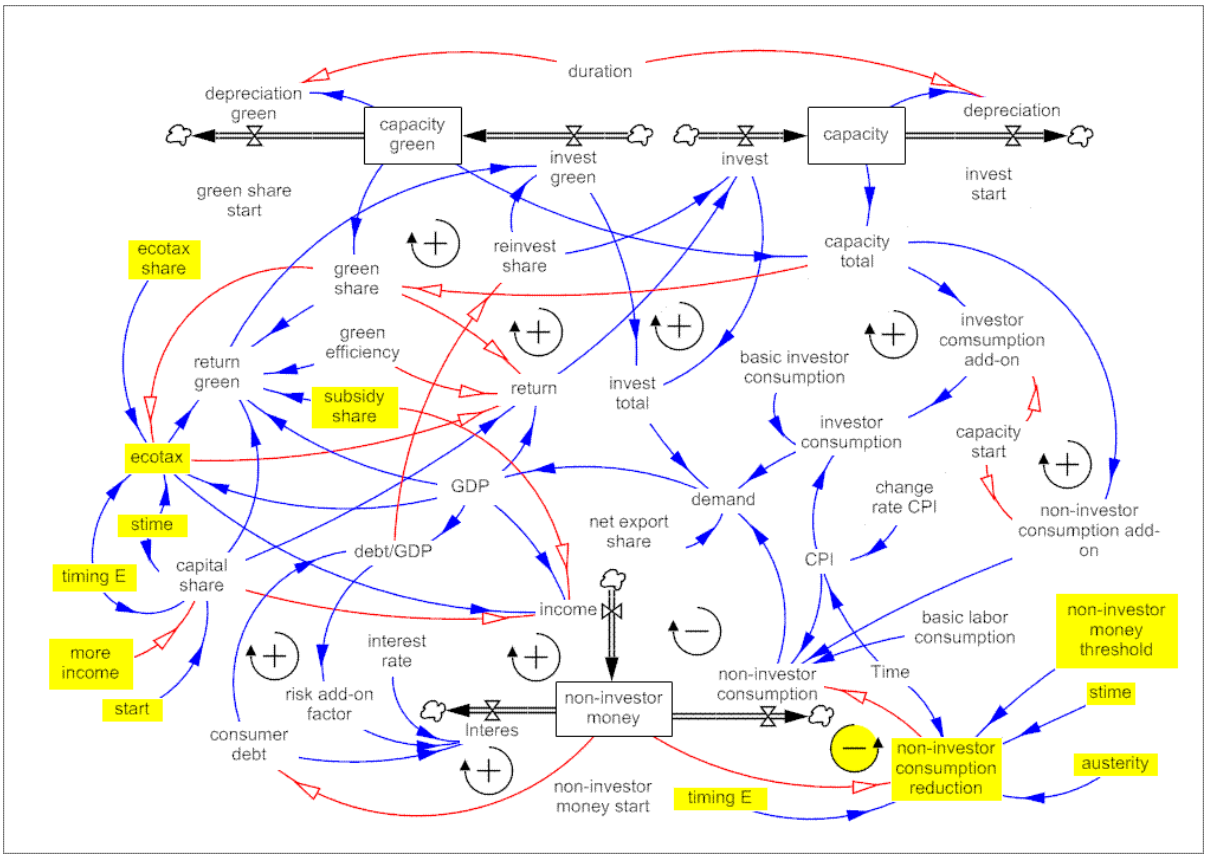


Figure 5: Three policy options to reduce debt and achieve rebalancing

As debts rise, a significant amount of income has to be used for repaying loans. Without taking more and more loans non-investors cannot hold their life standard, i.e. their level of consumption. To counter indebtedness non-investors might be forced to implement debt reduction policies, like `austerity`. Although austerity indeed contributes to reduce at least the growth of public and private debts, such a reduction happens at the cost of economic development because of resulting in a `non-investor consumption reduction` (Figure 5). Compared to austerity, achieving `more income` of public and private households seems to be a better method to limit and reduce debt while enhancing economic growth (Block 2013).

The simulation results of the previous SD model illustrate that decreasing inequality is a much more preferable policy than austerity. However, a sustainable economy does not necessarily result in a green economy. The updated model enables users to analyze the effects when an `ecotax` is in place. An ecotax is aiming to promote environmental behavior and is usually charged on the utilization of non-renewable resources. An ecotax not only contributes to the preservation of non-renewable resources and to the decrease of environmental pressure by forcing investors to invest in green technologies and systems (capacity green) instead of classical ones (capacity), ecotax revenues can also be distributed to non-investors in order to counter inequality.

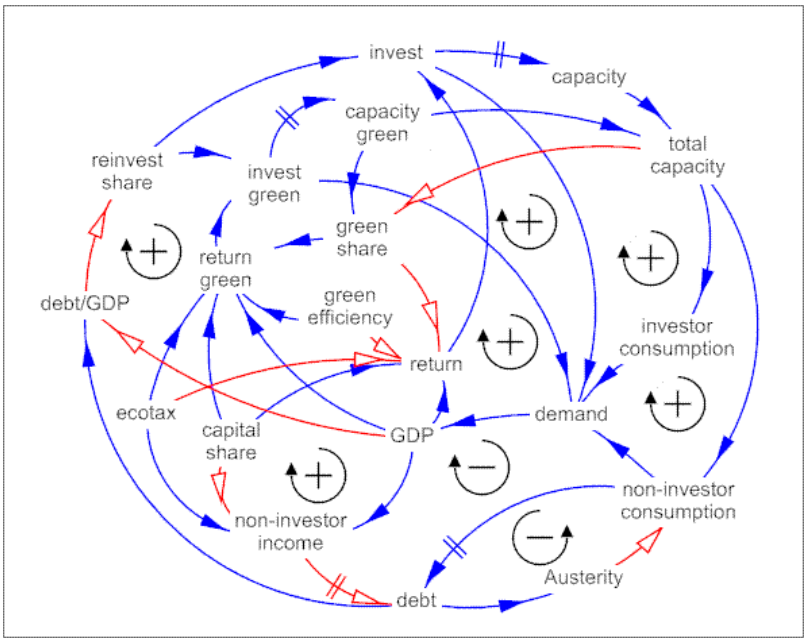


Figure 6: Causal loop diagram

Figure 6 shows a causal loop diagram which gives a simplified view of the model discussed in this section. It is obvious that there are multiple loops and side effects which make numeric simulations necessary.

4. Simulation results

We have conducted simulation runs with different ecotax policies and analyzed the effects on GDP, consumer debt levels, and investment. The policies under investigation are (a) no ecotax, (b) an ecotax is in place and fully redistributed to the non-investors, (c) 100% of ecotax revenues are used to subsidize green investments, and (d) 26% of ecotax revenues are used to subsidize investments in green technologies and systems. In addition, an adaptive sensitivity analysis has been carried out on the effect of green efficiency on the development of green share.

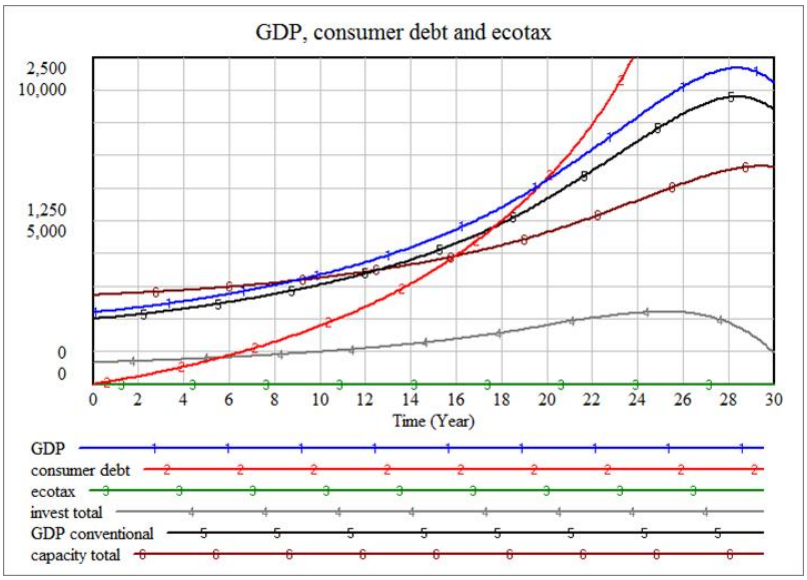


Figure 7: A non-sustainable growth. Notice that only `capacity total` *has a fourfold range on the Y-axis. The units are B€ and B€/a.*

Figure 7 illustrates the baseline scenario (a). Debts of consumers rise sharply. GDP increases until it peaks in the 27th year and falls afterwards because a high indebtedness will discourage further investment. The economy shows a non-sustainable growth because of the exponential growing consumer debt.

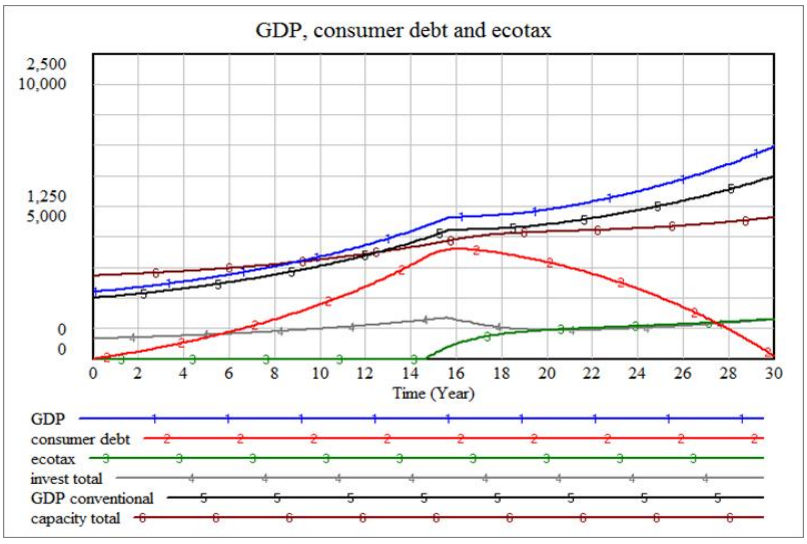


Figure 8: Sustainable finance through ecotax

If an ecotax (b) is introduced at year 15 the situation changes completely. In the scenario shown in Figure 8 all the ecotax revenues which have an amount of about 23% of the revenues generated by conventional capacity are distributed to the consumers to achieve more income equality. The consumers in turn use this additional income for non-credit financed consumption or to repay loans. Logically the revenues generated by green capacity are free from ecotax. Ecotax does have a short-termed negative impact on economic growth. However, because of its redistributive effect the ecotax contributes positively to sustainable economic development in the long run. The economy benefits from a slight growing GDP, drastically reduced debt-levels, and steady investments. This is what can be called a sustainable finance.

The desired ecological impact is rather small: the growth rate of `GDP conventional` or the GDP produced or served by conventional capacity is only slightly below the one of GDP.

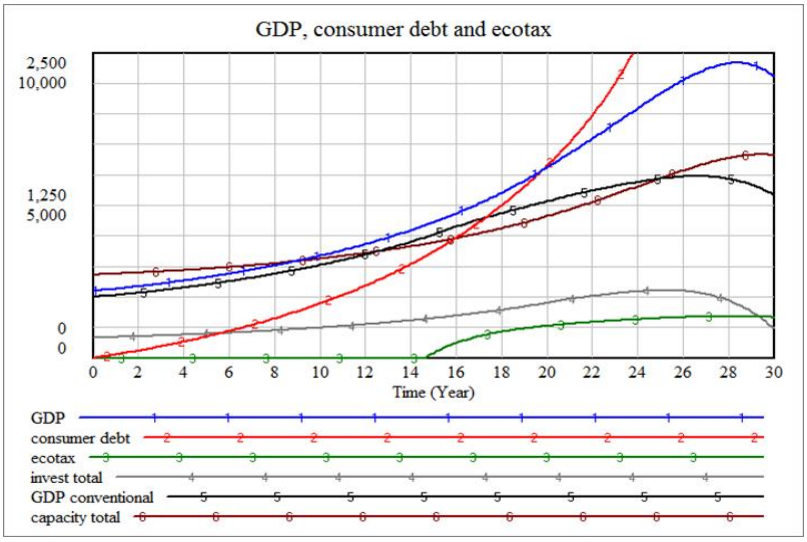


Figure 9: Using all ecotax revenue to subsidy „green" investments

The next simulated scenario is that all revenues from the ecotax are used for investment in green technologies and systems (c). The outcome shown in Figure 9 is very similar to the policy without ecotax (a). The sole difference is that GDP conventional differs significantly from GDP. Like in scenario (a) and in contrast to the expectation, using all ecotax revenues for green investment does not result in an inclusive green growth. There is a greening effect. However, it does not sustain because of the exponential growth of debts.

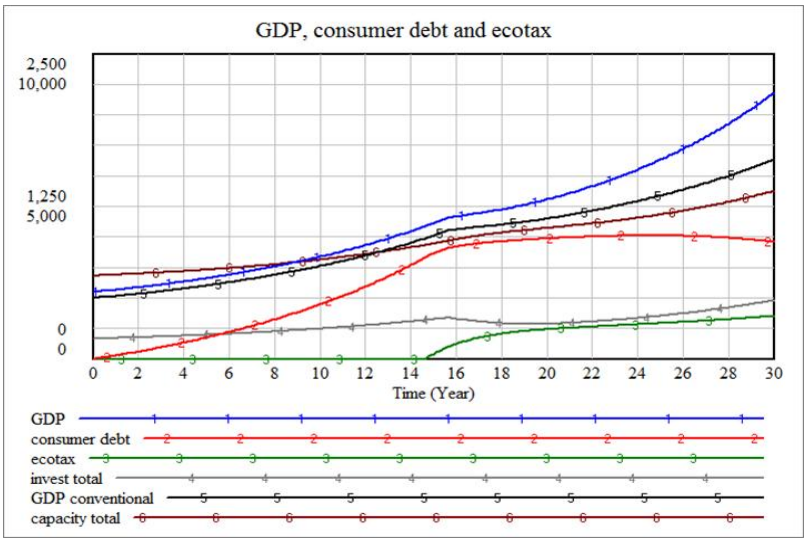
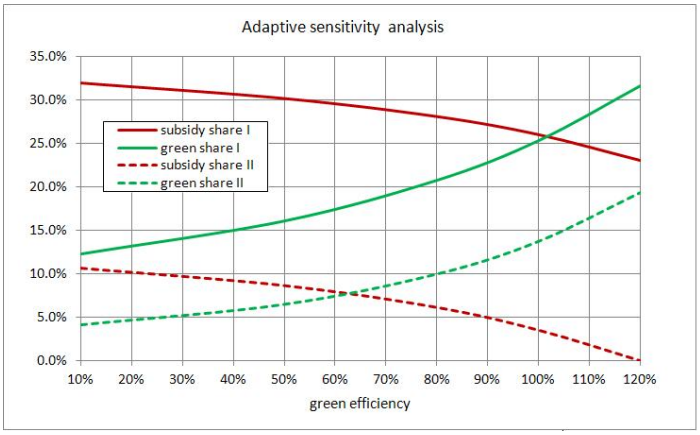


Figure 10: Using a part (26%) of the ecotax revenue to subsidize „green" investments

Figure 10 illustrates the impact upon the economy if 74% of ecotax revenues are redistributed to consumers and the rest is taken for subsidy of green investments. In contrast to policy (b) GDP has a much higher rate of growth. Debts stop increasing. Remarkable is that total investment does not change significantly: conventional investments are replaced by green investments. The desired ecological impact becomes visible: GDP conventional does not

grow at the same rate of GDP. The intensity of the usage of non-renewable resources decreases.



green efficiency	10%	50%	80%	100%	120%
ecotax share I	23.5%	23.5%	23.5%	23.5%	23.5%
subsidy share I	32.0%	30.2%	28.1%	26.0%	23.0%
green share I	12.3%	16.1%	20.8%	25.3%	31.6%
GDP (B€)	2165	2165	2167	2169	2169
comsumer debt (B€)	929	927	930	930	928

green efficiency	10%	50%	80%	100%	120%
ecotax share II	17.3%	17.3%	17.3%	17.3%	17.3%
subsidy share II	10.6%	8.6%	6.1%	3.5%	0.0%
green share II	4.2%	6.5%	10.0%	13.7%	19.3%
GDP (B€)	2161	2161	2162	2162	2168
comsumer debt (B€)	930	929	930	928	929

Figure 11: An adaptive sensitivity analysis

Based on (d) an adaptive sensitivity analysis has been carried out to identify the effect of the green efficiency upon the development of the green share. As shown in Figure 11, the higher the green efficiency, the higher the green share will be reached in the 30th year, and the lower the subsidy share is to be set to reach the target values of GDP and consumer debt of about 2165 B€ resp. 930 B€. The ecotax provides sufficient political alternatives for achieving both economic and ecological goals.

5. Conclusions

Economic developments often contain two major unsustainable trends at the same time: indebtedness and depletion of non-renewable natural resources, which particularly include fossil energy sources and unpolluted air, water and soil. This paper examines the possibility to combine the efforts for socio-economic improvement and environment protection through an ecotax.

Based on a previous model analyzing the relationship between economic growth and consumer debt from a financial and redistribution perspective, the model extension allows to analyze the effects if an ecotax is imposed and the revenues are spent in several different ways. The total production, service and innovation capacity of a real national economy is depicted in this model by a combination of a green capacity, which does not consume non-renewable resources at all, and of a conventional capacity consuming fully non-renewable resources.

The model simulations show that ecotax does have a short-termed negative impact on economic growth. Because of its redistributive effect the ecotax contributes positively to sustainable economic development in the long run. The prerequisite is that a significant share of the ecotax revenues is used to improve income of households and thus reduces indebtedness in the national economy. In contrast, fully using tax revenues for subsidy of green investments will fail because a high and increasing debt to GDP ratio will slow down both conventional and green investment and lead even to an economic crisis providing even less headroom for sustainability policies. Properly imposed and meaningful spent, ecotax seems to be an important instrument to achieve inclusive green growth and sustainable finance.

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