Towards a sustainable society: Concept for an alternative economic system

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The best state for human nature is that in which, while no one is poor, no one desires to be richer, nor has any reason to fear being thrust back by the efforts of others to push themselves forward.

John Stuart Mill

1 Introduction

The activities of mankind during the last centuries have changed the state of the world in such a way that the means of livelihood for future generations are threatened. This development has its cause in the industrialization induced by capitalism. Although capitalism created much progress in improving living conditions it led finally to abundant consumption and as a side effect it generates an increasing social inequality that results from the skewed income distribution [e.g., Kremer (2012), Piketty (2014)]. The capitalistic economic system has meanwhile spread over the whole globe and its international network takes the decisions leeway of the democratically legitimated governments [e.g., Rodrik (2011)]. Establishing a sustainable and fair society requires an alternative economic system.

In contrast to previous economic crises the problem now goes beyond the occurrence of unemployment, poverty and social inequalities. A necessity for turning the times also results from the finite amount of natural resources and increasing pollution both of which threaten the humane livelihood of the world population [e.g., Randers (2012)]. The capitalistic economy stimulates wasteful consumption for which humans of the lower class must work hard and often under degrading conditions. The production of consumer goods does not follow the basic human needs but strives for maximum profit. Therefore, goods will often be produced that can only be afforded by people living in abundance. Often such goods are superfluous and increase quality of life only slightly. However, capitalism forces increasing consumption, because it is a system-immanent necessity for the maintenance of the economic cycle [e.g., Binswanger (2009)]. If the cycle is weakened, then increasing unemployment results, that is, a part of the community members is excluded from economic life while the other part remains fully employed. A fair division of labor, to be realized by a reduction of working time is not availed. The supposed solution to reach full employment by public investment [a policy based on the widely known General Theory by Keynes (1936)] represents in no way the right alternative because the higher national debt and, therefore, the higher interest payment lead to dependency on financial markets that threat the sovereignty of democratic countries. The current debt crisis of the European Union clearly demonstrates this problem [e.g., Scharpf (2011)]. Moreover, public investment often triggers superfluous work and superfluous consumption.

In this paper an alternative economic system is proposed that can be more in line with a sustainable development. At first, the problems of the current capitalistic free market economy are clarified in section 2. Section 3 introduces the basic principles of the alternative economic system and section 4 describes its macroeconomics at the national level. In section 5 and 6 the regulation of wage and tax on assets are explained, respectively. Section 7 contains some concluding remarks.

2 Macroeconomics of the current capitalistic system

The fundamental difficulty of the capitalistic free market economy already becomes apparent in the neoclassical macroeconomic model. This model is presented in textbooks to give reasons for the stability of the capitalistic system [e.g., Felderer and Homburg (1992)]. It postulates the invisible hand of the free market that prohibits an intervention by the government. In the following it is shown that the opposite is true because the neoclassical model exhibits a tendency towards crises that can only be overcome by continuous technological progress. **Fig. 1** delineates the schematic cycle in this model. It is represented by the tripartition of the model into the stocks households *H*, firms *F* and assets *A*.

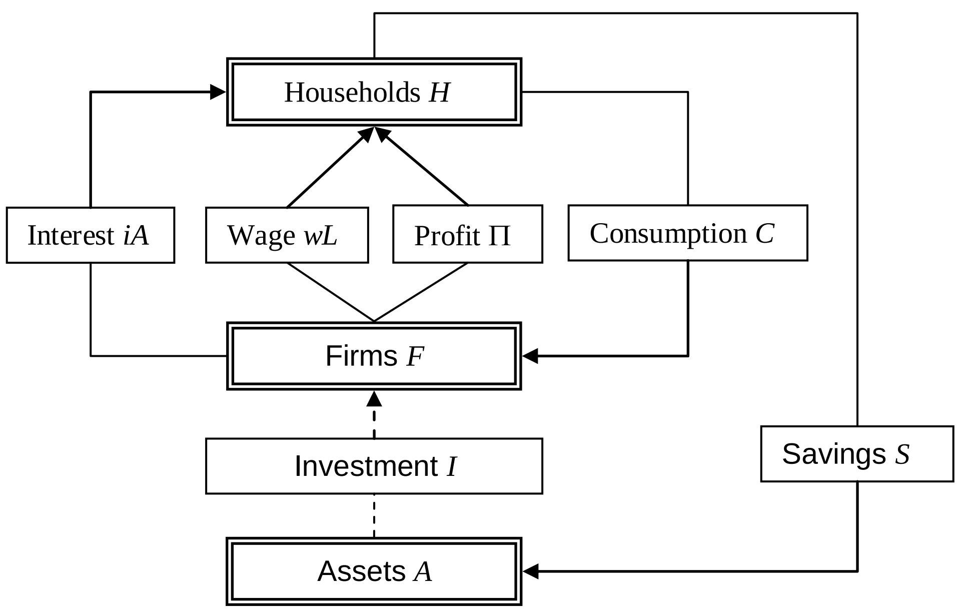

Fig. 1. Schematic cycle in the neoclassical model. The arrows describe the monetary flow and the dashed investment arrow indicates that the monetary flow is bound to a liability towards the investor.

The model only describes aggregated quantities, i.e. only the total amount of goods and financial resources will be calculated. It must be distinguished between stock and flow variables. All quantities in this section are referred to real (material) values and the following notation is used:

Stock variable		Flow variable		Cost factors	
H	Households	C	Consumption	w	Wage
F	Firms	Π	Profit	i	Interest rate
A	Assets	S	Savings		
K	Real capital	L	Labor		
		I	Investment		
		Y	Production		

The model is based on the following balance:

$$Y = C + I\,. \tag{1}$$

Therefore, total production Y comprises the production of consumer goods and capital goods (means of production). At the same time Y forms the total real income of the households that will be spent on consumption C or savings S otherwise. Consequently, savings are equated with capital investment. The firms sell, in a manner of speaking, their capital goods to wealthy investors and through the interest they demand a kind of fee for the utilization of the sold capital goods. One gets the impression that the economy can only work by the rental of capital goods in the form of investment. But this is a fatal conclusion because hereby the foundation for the increasing inequality was laid. The savings of few wealthy investors lead to an increase of their property in capital goods. Because of the interest, they obtain additional unearned income which further increases their property. The additional property justifies further interests so that eventually a positive feedback loop results (interest on interest effect). Consequently, the property distribution becomes increasingly skew [e.g., Kremer (2012), Piketty (2014)] and a class arises that owns everything and demands a kind of fee for the use of their investment goods.

To attain further understanding, it is necessary to consider the so-called production function in the neoclassical macroeconomic model. The production Y depends solely upon the amount of labor L and capital K. Therefore, a relation Y=Y(L,K) exists. This function satisfies, in neoclassical economic theory, the law of diminishing returns to labor and capital and, therefore, the production function $Y(L,K)$ must have a concave functional dependence on L and K. Hence, the profit maximizes at a certain capital labor ratio K/L for given total amount of capital. In this case the production facilities as well as the employees are optimally utilized. The costs for labor are calculated by wL where w denotes the wage rate. At the same time the costs for the paid investments results from the interest iA where i denotes the interest rate. Consequently, the firms earn the following profit

$$\Pi = Y - wL - iA. \qquad (2)$$

The labor L and investment I follow from supply and demand that in neoclassic theory give rise to a balanced wage w and balanced interest i. Then, every supply of consumer goods finds its demand according to Say's theorem of neoclassic theory [see e.g. Felderer and Homburg (1992)]. The price P establishes a conversion from monetary to real values. It results from the Cambridge equation that relates the total amount of money M to the production Y by the equation $P=vM/Y$ where v is the velocity of money. These conclusions leave the impression that the neoclassic economic model features a stable equilibrium. But this is not the case because an equilibrium state cannot exist when only a small group of wealthy people benefits from total profit (profit and interest). Instead, the system tends to crises if economic growth cannot be maintained by technological progress. This predication follows from the fact that the profit Π becomes negative if the consumption C, investment I and labor L do not change in time as it is required for the alleged equilibrium. The investment I comes along with a continuous growth of the assets A:

$$A = I\,t, \qquad (3)$$

where t denotes time. Therefore, the profit Π becomes negative at the time $t=(Y-wL)/(i\,I)$. However, the firms will not accept this development and will either deny further investments or increase their production. In the latter case a maximization of profits is intended and its consequences can be explicitly determined if the neoclassical production function is given by the widely known Cobb-Douglas function [Cobb and Douglas (1928)]:

$$Y(L,K) = c_Y L^{\alpha} K^{1-\alpha} \quad . \tag{4}$$

Here, the special case α=1/2 is assumed for simplicity. For given values of K and w the real profit maximizes if the amount of labor is calculated by

$$L = \left(\frac{c_Y}{2w}\right)^2 K \quad . \tag{5}$$

From this relation the capital to labor ratio K/L can be deduced for which the utilization of capital and labor becomes optimal. The profit maximization leads to an increase of labor with growing capital. This can be seen in **Fig. 2** that displays profit as a function of labor for various capital values. A path along the heavy arrows describes an economic development in accordance with profit maximization.

The saving ratio s measures the invested fraction of the real household income Y. The investment resulting from the savings does not only increase the amount of capital but it also serves to recover already existing capital which depreciates at the rate δK. Furthermore, the real income becomes a function of capital K only if one assumes profit-maximizing utilization of labor. Then, the following differential equation results

$$sY = sc_Y\sqrt{LK} = I = \frac{dK}{dt} + \delta K \underset{\text{Profit maximization}}{\rightarrow} \frac{dK}{dt} = \left[s\,\frac{{c_Y}^2}{2w} - \delta \right] K \quad . \tag{6}$$

This differential equation has a solution that exhibits exponential growth, namely

$$K = K_0 \exp(\sigma t) \text{ with } \sigma = s\frac{c_Y^{\,2}}{2w} - \delta . \tag{7}$$

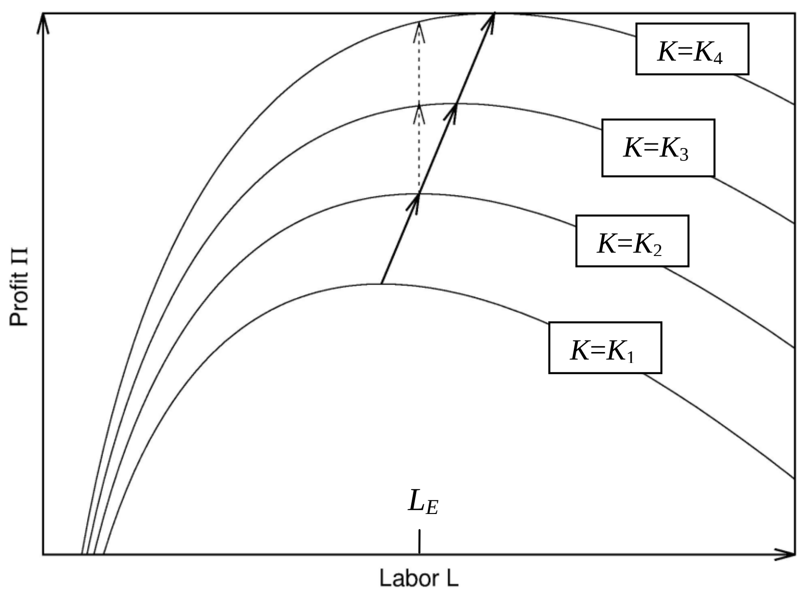

Fig. 2. Profit Π as a function of labor L for various capital values $K_1<K_2<K_3<K_4$. The solid arrows indicate the optimal path for economic development while the dashed arrows show the development when the amount of labor is limited by L_E.

Capital grows exponentially with the growth rate σ and this is also true for all other quantities as, e.g., the profit of the firms. Therefore, the firm profit never reaches a maximum where the economy could equilibrate. Nevertheless, limit of growth will eventually be reached because of constraints due to pollution and limited availability of natural resources. Anthropogenic natural disasters as for example the global climate warming are inevitable consequences of the capitalistic economic system that enforces endless growth. However, the growth of labor has also its limitation since the number of laborers is finite. Curiously, the amount of labor increases due to economic growth although full employment is never reached in the industrial nations. Instead a continuous increase of production was possible by relocation of production abroad and technological progress. But these measures have also their limitations and it can be concluded that exponential economic growth only works in an infinite world with unlimited growth of employees. The latter requires an unlimited growth of the world population.

The neoclassical economic growth model of Solow (1956) may include the correct assumption that the labor cannot constantly increase and must reach a maximum value L_E if the world population does not increase. In this case the economic development path follows the dashed arrows in **Fig. 2** and capital grows until it reaches an equilibrium which results from the balance

$$sY_E = \delta K_E \quad \leftrightarrow \quad sc_Y \sqrt{L_E K_E} = \delta K_E, \tag{8}$$

where the index E indicates the equilibrium value. At this equilibrium state growth vanishes. The way to and whether the equilibrium state can exist depends on the kind of investment. Three cases are imaginable:

i) The investment is used by the employer to produce new capital and to re-establish already existing capital.
ii) The investment is used by the employer only to produce new capital while the depreciation costs are borne by the investor.
iii) The investment is used by the employer only to produce new capital while the employer pays the depreciation costs with the firm profit.

With case i) the assets continue to grow after the capital has reached its equilibrium since the investment to recover depreciating capital still increases the assets, that is, the following equation holds

$$I = \frac{dA}{dt} = \frac{dK}{dt} + \delta K. \tag{9}$$

Therefore, the assets rise eventually with the time tendency δK. **Fig. 3** displays schematically how assets A (monetary capital) and capital K (real capital) develop in this case. The monetary capital and real capital paths diverge and, consequently, monetary capital becomes fictive capital that has no real value. The interest grows and, eventually, the firm profits will collapse if the interest rate does not decrease.

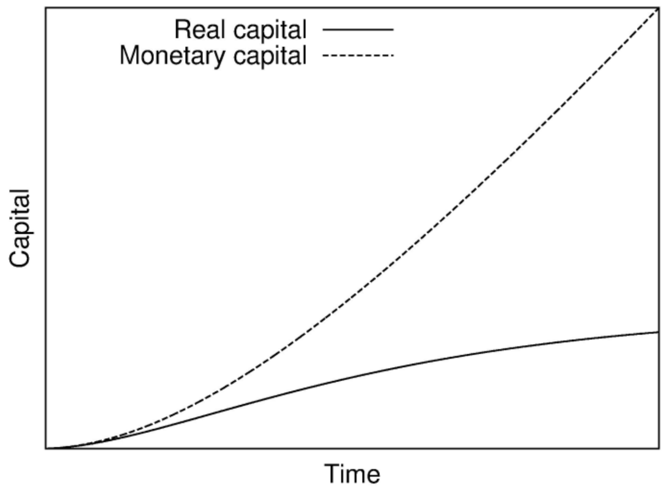

Fig. 3. Development of monetary and real capital in Solow's model.

With case ii) the investor takes over the costs of depreciation. The investor provides the firm with new capital at interest but the costs for the maintenance of existing capital must be paid by the investor. Then, the identity

$$\frac{dA}{dt} = \frac{dK}{dt} \tag{10}$$

holds. Now, the increase of assets vanishes at the equilibrium state and this has the consequence that saved income will be completely paid for depreciation costs. In this case it is not profitable anymore to own real capital since it does not yield returns. In such a situation the investors would not take over the risk to invest in real capital but they would retain their money due to the liquidity premium [cf. Keynes (1936), Loehr (2012)] or invest it in fictive or non-productive capital that promises higher returns. Such deprivation of money from the productive part of the economic cycle eventually leads to an economic crisis.

With case iii) the depreciation costs are financed by the firms instead of the investor.[1] This can for example be realized by increasing the prices of the produced goods. Now, the capital increases in time with the investment I and the following differential equation describes the development:

$$\frac{dK}{dt} = sc_Y \sqrt{L_E K}\,. \tag{11}$$

This equation predicts unlimited growth of capital. However, the interest and depreciation costs of the firms eventually exceed the income due to the concave shape of the production function. So, the economy also collapses in case iii).

In all three cases the profit rate (firm profit plus interest divided by capital) decreases steadily and eventually vanishes. Karl Marx came to a similar conclusion in his Capital, Volume III [Marx (1894)]. Marx explains the cause of the falling profit rate in a different way. However, the discrepancy in the explanations is only of minor importance when the result is the same. The neoclassic approach emanates from Say's theorem that manifests optimal marketing conditions. Therefore, shortages of demand that give rise to an overproduction crisis cannot occur. Nevertheless, a fall of the profit rate and a subsequent economic crisis takes place even under such conditions. The conditions in Keynesian and Marxian economics are less optimistic and, consequently, they provide other reasoning for the crisis-laden nature of capitalism. Therefore, one can assume that alternative theories cannot invalidate the explanations for the aforementioned difficulties. Moreover, the tendency for crises becomes more dramatic in the future due to the limited amount of natural resources.

[1] In Solow's article [Solow (1956)] this assumption is made while many textbooks introduce his model in such a way that the investor pays the depreciation costs [e.g., Barro and Sala-i-Martin (2004)].

The reality also shows that national economies without growth fall into a state of crisis like the financial crisis 2007/2008 [e.g., Foster (2008)]. Destruction of capital (e.g. by a war) or technological progress becomes necessary to overcome economic crises. The latter increases the technology parameter c_Y but also this measure has its limitation and it leads to an increase of useless consumption that wastes natural resources. For a true equilibrium the saving ratio s must vanish so that the expenses for consumption finance the necessary amount of labor to produce the goods and re-establish the existing capital. However, this is not possible due to the extremely inhomogeneous distribution of assets and income. Owners of large assets are hardly able to spend their capital income entirely on consumption.

3 Principles

The problems of the current economy can only be overcome by the creation of an alternative economic system. Essentially, two interconnected processes must cease, namely i) the unearned accumulation of property by a minority via interest, speculation or firm profit and ii) the increasing exploitation of non-renewable natural resources as well as the associated pollution. This becomes possible by a redistribution of property and a decrease of consumption. The latter causes to a certain extent a loss of wealth in the industrial nations but this is inevitable in view of the current threatening situation. The overarching aim of the alternative economic system consists in the establishment of humane living conditions for all people in this world in the long run. In agreement with this aim it must be distinguished between useful and expendable labor. Only useful labor serves the above-mentioned purpose while expendable labor should be limited. The national level forms a fundamental structure of the alternative economic system. Each nation receives as much economic autonomy as possible.

However, a superordinated global community is required due to the very inhomogeneous distribution of natural resources and technologies. This community manages technology transfer and controls the fair and sustainable spreading of natural resources that cannot be exploited in every country. Consequently, the alternative economic system is divided into a national and a global level. These are invested with meaning by the subsequent principles.

National level

1. Each nation receives its own currency that serves as a medium of exchange. The whole amount of money is conserved, that is, no additional money can be created.

2. The banks are replaced by a democratically authorized agency that redistributes money in order to avoid hoarding of money by the upper class of the society. A tax on monetary assets serves this

purpose. The tax received is returned into the economic cycle by useful investments and necessary public spending.

3. Residential property should be owned by the inhabitants. Otherwise they are in the custody of the government to prevent enrichment by the rent. Other types of real estate property should be owned by the national state and can be allocated to firms. The remaining real estate property is subject to a tax that will gradually convert private into national property.

4. The firm holders (entrepreneur) share a part of their profit with the staff according to their individual amount of labor. This share increases with the size of the firm but a part of the profit is still allocated to the entrepreneur. Then, the entrepreneur has profit opportunities and is therefore motivated to take on responsibility for the firm and bear the business risk.

5. Entrepreneurs must live in the country where the firm is located.

6. The production is limited to approach a sustainable economy. This necessitates a limitation of the average weekly hours of work when labor is fairly distributed. The positive effect is a gain of leisure time that can be used by the citizens for a self-determined life.

7. A defined fraction of the income can be saved for the old-age pension. This part of the assets is not taxed.

8. Import and export of goods go along with wasting of natural resources due to the transport and has to be minimized. Therefore, import and export is restricted to goods and raw material that cannot be produced and mined in the respective countries. An exploitation of one country by another is also avoided by this measure.

9. It is necessary to differentiate between useful and expendable labor. Useful labor serves for the maintenance of a humane livelihood in the present and future. Expendable labor, however, leads to unneces-

sary consumption and endangers the life of future generations. Promotion of useful labor and minimization of redundant labor has to be accomplished by the investment policy of the government.

10. A sustainable economy requires the use of renewable resources. Therefore, firms that do not use renewable resources are not supported by investments if they have the possibility to do that. The introduction of a resource and pollution tax serves to trigger technological progress in the use of renewable resources.

<u>Global level</u>

1. All nations (countries) can become part of a global community. The exchange of natural resources and technologies that are not available in every country is regulated by a global government of this global community. The global government is democratically legitimated by the member nations. On one hand it has the duty to satisfy the need for natural resources of all countries and on the other hand it is responsible for minimizing the natural resource usage so that humane living conditions of future generations are ensured. An independent sustainability council represents the interests of future generations. It decides together with the global government about the extent of non-renewable resource mining.

2. A global currency is introduced for an equitable distribution of natural resources and the associated amount of labor. It is used for the international trade in natural resources. The prices conform according to equivalent economic principles [Peters (1996)] to the amount of labor that is necessary to mine and transport the desired natural resources and to transfer technologies. This implies that the value is measured in terms of labor and allows countries with low productivity to satisfy their needs. Countries with few resources must compensate the low amount of labor for mining by selling useful goods or services to other countries having many resources. The global community assists a country in self-help if the imports

exceed the exports on average. This is necessary as long as the living conditions would fall below the poverty line otherwise.

4 Macroeconomics at the national level

The main concept of the alternative economic system is explained with a mathematical macroeconomic model which is limited to the national level. The economy of the global system is regulated by a global government as explained above and yields an exogenous allocation for natural resources which is treated as a constant in the model.

The macroeconomic model comprises a monetary cycle and a material process that converts natural resources into goods and capital. These counterparts yield together the macroeconomic dynamics. The mathematical model has four dimensions: Real value $\mathcal{R}$ (goods, capital and natural resources), monetary value $\mathcal{M}$ (money), labor $\mathcal{L}$ and time $\mathcal{T}$. It is useful to base real values on natural resources due to their scarcity.

The monetary cycle determines the aggregate quantities

A Assets of the households [$\mathcal{M}$]
F Assets of the firms [$\mathcal{M}$]
N Assets of the national state [$\mathcal{M}$]

The material conversion of natural resources constitutes on the other hand the aggregate quantities

R Amount of natural resources [$\mathcal{R}$]
W Unsold consumer goods (wares) [$\mathcal{R}$]
G Sold consumer goods [$\mathcal{R}$]
K Capital goods of the firms [$\mathcal{R}$]

The monetary flows and material conversions of the national economy model are illustrated in **Fig. 4**. They depend upon many factors and they will be formulated in a macroeconomic framework as a function of the above-mentioned aggregate quantities:

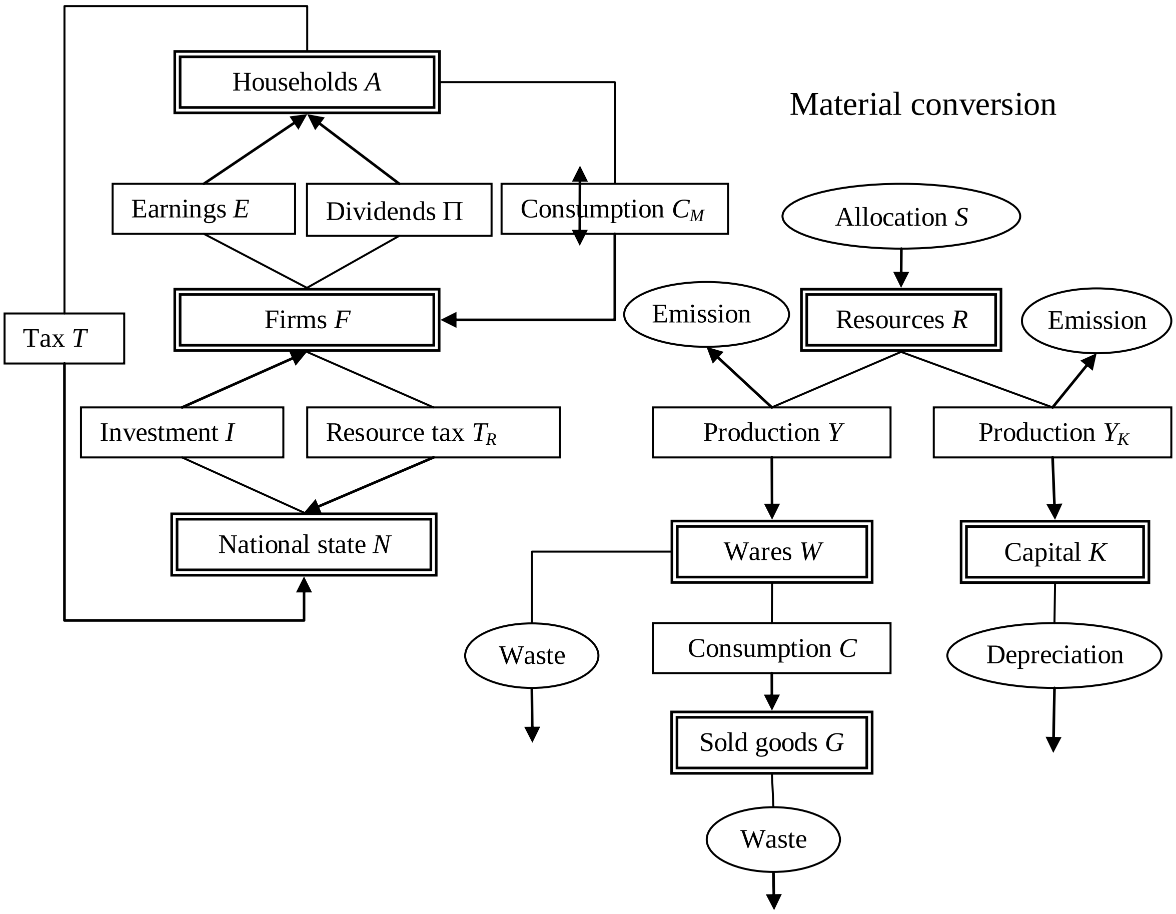

Fig. 4. Monetary cycle and material conversions of natural resources in the macroeconomic model.

- Tax on assets: $T = c_T\,(A - A_E)\;[\mathcal{N}/\mathcal{T}]$

The tax on assets T is proportional to the difference between assets of the households A and its equilibrium value A_E. The parameter c_T represents a time rate with which the assets A adjust to the equilibrium by the tax.

- Expenditures on consumer goods $C_M = c_P\,(1 - G/G_S)\;A\;[\mathcal{N}/\mathcal{T}]$

The monetary expenditures on consumer goods results from the demand that is prescribed here by the product of assets A and needs (1-G/G_S). The formulation is based on a plausible argument. The higher the assets are, the larger is the willingness to spend money for consumer goods. However, the households do not spend their complete assets since many save money for a larger acquirement or on grounds of caution. The consumption decreases with increasing amount of goods G and it stops at the saturation value G_S. This formulation agrees with Gossen's first law that marginal utilities are diminishing [Gossen (1854)]. This means that the demand for additional consumption decreases with increasing consumption until saturation takes place. The saturation value normally exceeds the material wealth which is appropriate for a sustainable society. Therefore, the economic system should operate in such a way that the wealth equilibrates at $G<G_S$. It has to be mentioned that the consumption could also depend on the income. Indeed, conventional macroeconomics includes the assumption that consumption exclusively depends on income [e.g., Felderer and Homburg (1992)]. Then, a dichotomy of the real and monetary sectors of the economy results, i.e., the monetary cycle immediately adapts to the real consumption and, consequently, the money supply has no impact on the material part of the economic cycle. This assumption appears questionable in consideration of the fact that inflation (too much money is available) and deflation (too little money is available) have indeed an impact on the real economy. A more realistic approach should let the consumption be a function of both the assets and the income. The discussion of this approach is shifted to the appendix since it complicates the mathematical treatment and makes the basics more difficult to understand. However, it will turn out that it leads to qualitatively similar conclusions.

- Earnings $E=w(L+L_K)$ [$\mathcal{N}/\mathcal{T}$]

The wage is calculated from the overall labor per time unit $L_t=L+L_K$ [$\mathcal{L}/\mathcal{T}$][2] multiplied with the wage w [$\mathcal{N}/\mathcal{L}$][3]. The overall labor L_t comprises the labor L and L_K for the production of consumer goods and capital goods, respectively.

[2] Usually and in the present paper, labor per time unit is simply denoted as labor.

[3] One can also interpret w as a wage rate if per time unit a worker provides the same amount of labor. Then, $\mathcal{L}$ can be measured in terms of working hours. However, this working time cannot be identified with the real time t in a macroeconomic model since the amount of total working hours greatly exceeds the amount of real hours in the considered time period.

- Dividends $\Pi = r_P\, [C_M - w(L+L_K) - T_R]$ with $0<r_P<1$ [$\mathcal{N}/\mathcal{T}$]

The surplus of the sales revenue C_M over paid earnings $w(L+L_K)$ and resource and pollution tax T_R (explained below) forms the profit. Only the fraction $r_P<1$ of the profit will be distributed as dividends while the fraction $(1-r_P)$ remains in the form of investment a property of the firms.

- Production $Y=c_Y L^{\alpha} K^{1-\alpha}$, $Y_K=c_{YK} L_K{}^{\alpha} K^{1-\alpha}$ [$\mathcal{R}/\mathcal{T}$]

The production rates Y for consumer goods and Y_K for capital goods are described by Cobb-Douglas production functions [Cobb and Douglas (1928)]. Therefore, the production rate does not depend only on labor L and L_K but also on real capital K (means of production)[4]. The larger the capital the smaller must be the labor to achieve a certain output. The dependence in form of exponentiation with the output elasticities $\alpha < 1$ and $(1-\alpha) < 1$ expresses constant returns to scale and the diminishing marginal productivity with increasing labor or capital. Furthermore, the exponent α is identical to the labor share of income in neoclassical theory [e.g., Barro and Sala-i-Martin (2004)].

- Real consumption $C=C_M/P$ [$\mathcal{R}/\mathcal{T}$]

The real consumption of consumer goods C results from the expenditures C_M divided by the price P.

- Waste and depreciation $D_W=W/\tau$, $D_G=G/\tau$ and $D_K=K/\tau_K$ [$\mathcal{R}/\mathcal{T}$]

Material goods decay and become waste due to their limited durability. This process is assumed to be linear so that wares, consumer goods and

[4] Strictly speaking one should distinguish between capital K_G for production of consumer goods and capital K_K for production of capital goods. This complication can be circumvented when a constant fraction $f_K=K_G/K_K$ is assumed so that $K= K_G + K_K = f_K/(1+ f_K)\, K + 1/(1+ f_K)\, K$. Then, the production functions can be written in the abovementioned form and the coefficients c_Y and c_{YK} depend on f_K.

capital decay at the rates W/τ, G/τ and K/τ_K, respectively. The constants τ and τ_K determine the time scale of the consumer goods decay and capital depreciation, respectively.

- Emission $D_Y=c_D\,(Y+Y_K)K$ [$\mathcal{R}/\mathcal{T}$]

The production facilities convert natural resources into consumer and capital goods. However, not all invested resources contribute to the final product since a part of them is lost by emission and, therefore, pollutes the environment (for example burning fuel by engines). This emission is set proportional to the total production rate $Y+Y_K$ and the amount of real capital K. Therefore, a reduction of natural resource usage results in the model when labor L substitutes capital K.

- Natural resource allocation S [$\mathcal{R}/\mathcal{T}$]

The global government fixes the allocation S with which the natural resources are distributed in every country according to their needs.

- Public investment $I=w(L_K-L_{KE})$ [$\mathcal{N}/\mathcal{T}$]

Here, L_{KE} denotes the amount of labor that is necessary to maintain the capital. The role that is adopted by the private investor in the current economic system will be assigned to the government. The investment takes place until the equilibrium is reached, that is, when $L_K=L_{KE}$. The firm holders must themselves pay for the depreciation costs at this equilibrium.

- Resource and pollution tax $T_R= c_RP\,(Y+Y_K)(1+f_Pc_DK)$ [$\mathcal{N}/\mathcal{T}$]

The resource and pollution tax is raised on natural resources that are used for the production of consumer and capital goods. The resource tax parameter c_R sets the height of the resource tax and the pollution tax multiplier $f_P>1$ yields an extra tax on pollution. This tax aims at making a resource-saving production more profitable and it stimulates the firm holder to modernize the production facilities. In the first place the tax is needed to pay the labor for the mining and transport of natural resources. The excess is spent on necessary public expenses. Therefore, the households lastly profit from the resource and pollution tax. A high resource and pollution tax could be used to establish an unconditional basis income but it is not guaranteed that it can cover the costs for a humane existence.[5]

The dimensions are defined in such a way that the constants G_S, w and $\boldsymbol{\tau}$ drop out of the mathematical system of equations. This becomes true when the real value [$\mathcal{R}$] is measured as multiple of G_S, the labor [$\mathcal{L}$] as multiple of a reference value L_R, the monetary value [$\mathcal{N}$] as multiple of $w \cdot L_R$ and the time [$\mathcal{T}$] as multiple of $\boldsymbol{\tau}$. Therefore, the identity $G_S = L_R = w = \tau = 1$ holds in the system. Furthermore, the reference labor L_R is prescribed so that $c_Y = 1$. The relation between L_R and c_Y results from the formulation of the Cobb-Douglas production function which gives $L_R = G_S / (\boldsymbol{\tau} c_Y)^{1/\alpha}$. A time dependence of c_Y and c_{YK} due to technological progress is not considered in the present model.[6]

The following dynamical system results from the abovementioned preliminary considerations:

$$\begin{aligned}\dot{A} &= -c_T\left(A - A_E\right) + L_K - L_{KE} - (1 - r_P) \times \\ &\times \left[c_P(1 - G)A - (L + L_{KE}) - c_R P\left(L^\alpha + c_{YK} L_K{}^\alpha\right)K^{1-\alpha}\left(1 + f_P c_D K\right)\right], \end{aligned} \tag{12}$$

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[5] However, the smaller group of unemployable and unemployed citizens should receive a sufficient basic income from the government in any case.

[6] Such kind of technological progress does not cope with sustainability since the natural resource usage increases with increasing c_Y and c_{YK}. Technological progress in agreement with sustainability must come along with the reduction of the saturation wealth G_S whereas an increase of c_Y and c_{YK} only facilitates the production process.

$$\dot{F} = (1 - r_P) \times$$
$$\times \left[c_P (1 - G) A - (L + L_{KE}) - c_R P \left(L^\alpha + c_{YK} L_K{}^\alpha \right) K^{1-\alpha} \left(1 + f_P c_D K \right) \right], \tag{13}$$

$$\dot{N} = c_T \left(A - A_E \right) - L_K + L_{KE}, \tag{14}$$

$$\dot{R} = S - \left(L^\alpha K^{1-\alpha} + c_{YK} L_K{}^\alpha K^{1-\alpha} \right) \left(1 + c_D K \right), \tag{15}$$

$$\dot{W} = L^\alpha K^{1-\alpha} - c_P \left(1 - G \right) \frac{A}{P} - W, \tag{16}$$

$$\dot{G} = c_P \left(1 - G \right) \frac{A}{P} - G, \tag{17}$$

$$\dot{K} = c_{YK} L_K{}^\alpha K^{1-\alpha} - \frac{K}{\tau_K}, \tag{18}$$

where the dot above a letter denotes a time-derivative of the corresponding variable.

The sum of the monetary cycle equations (12)-(14) yields the conservation of the total money supply *M*. Therefore, the relation

$$A + F + N = M = konst. \tag{19}$$

holds and the money supply *M* does not alter.

The dynamics of the national economic system must be stable in order to represent a reasonable alternative to the present non-sustainable economy that is prone to crises and social inequality. The existence of a stable equilibrium ensures the stability of the system if the initial state is not too far away from this equilibrium where all flow variables are balanced and all stock variables do not change with time. It is of importance to know whether the system adjusts inherently to a given natural resource allocation *S* or the government must control the system in such a way that the production manages with *S*. The latter is true in the present model and, therefore, the system does not automatically approach for arbitrary model parameters a steady state in which the natural resource allocation balances the usage. However, the government can adjust the taxes in such a way that balance is fulfilled and temporal surpluses in natural resources can be stored or left to other countries. Therefore, the natural resource equation (15) is ignored in the following and the controllability by taxes will be demonstrated. To find a solution of the system it is necessary to determine the labor and the price as a function of other model variables. Therefore, additional relations must be introduced as described below.

Some plausible assumptions facilitate the determination of the equilibrium solution. First, the parameter r_P is set to 1 to allow a complete distribution of profit to the households. Then, the tax on assets T and public investments I can vanish at equilibrium.[7] In this case the assets are distributed as follows:

$$A = A_E,\ F = 0,\ N = M - A_E \equiv N_E\ . \tag{20}$$

Therefore, the government can enforce any value for the assets A_E of the households at the equilibrium state. It is also possible for the government to control the material wealth as measured by G with the choice of A_E because at equilibrium equation (17) yields

$$G = \frac{A_E}{P / c_P + A_E}\ . \tag{21}$$

The firm holders regulate the price P and the amount of labor L+L_K. The price should be so low that all consumer goods can be sold. Therefore, in the optimal case of such a market clearing the amount of wares W

[7] It is also imaginable that T=I≠0 holds at the equilibrium state. Then, permanent public investments become necessary for the support of the economy. Such a situation could, e.g., result from repeated occurrences of firm failures leading to elimination of capital. Such a “frictional” effect is for simplicity excluded in the present model consideration.

becomes zero. This idealization is adopted here with the consequence that the identity Y=C holds from which the price P can be determined as described below.

The amount of labor L for the production of consumer goods results from profit maximization. The profit is given by

$$\begin{aligned}\Pi &= C_M - L - L_K - T_R = PY - L - L_K - c_R P\left(Y + Y_K\right)\left(1 + f_P c_D K\right) \\ &= P\sqrt{LK} - L - L_K - c_R P\left(\sqrt{LK} + c_{YK}\sqrt{L_K K}\right)\left(1 + f_P c_D K\right) \quad ,\end{aligned} \tag{22}$$

where $\alpha = 1/2$ has been assumed for simplicity. The solution of a more general model including an unspecified α is discussed in the appendix. Therefore, the profit maximizes for fixed K and L_K when

$$L = \frac{P^2\left[1 - c_R\left(1 + f_p c_D K\right)\right]^2}{4} K \ . \tag{23}$$

At equilibrium the labor L_K can be deduced from equation (18):

$$K = c_{YK}\sqrt{L_K K}\tau_K \quad \leftrightarrow \quad L_K = \frac{K}{\tau_K{}^2 c_{YK}{}^2} \ . \tag{24}$$

Then, the labor L_K is exclusively utilized for the maintenance of existing capital K and the profit becomes:

$$\Pi = \left\{\frac{P^2}{4}\left[1 - c_R\left(1 + f_p c_D K\right)\right]^2 - \frac{1}{\tau_K{}^2 c_{YK}{}^2} - \frac{c_R P}{\tau_K}\left(1 + f_p c_D K\right)\right\} K \ . \tag{25}$$

Obviously, the price has to be sufficiently high for a positive profit. The price results as already mentioned from the assumed identity of production and consumption at equilibrium:

$$Y = C = G \quad \rightarrow \quad \sqrt{LK} = \frac{P}{2}\left[1 - c_R\left(1 + f_p c_D K\right)\right]K = \frac{A_E}{P/c_P + A_E}. \qquad (26)$$

The solution of this identity reads

$$P = -\frac{c_P A_E}{2} + \sqrt{\frac{\left(c_P A_E\right)^2}{4} + \frac{2 c_P A_E}{K\left[1 - c_R\left(1 + f_p c_D K\right)\right]}}. \qquad (27)$$

Therefore, the government can control the price by prescribing the equilibrium assets A_E of the households since the price P increases with increasing A_E.

It is still not clear what controls the amount of capital K at equilibrium. In a free market economy investments in capital are worthwhile as long as they increase the profit. Due to the diminishing returns to capital a maximum of the real profit G/P arises for a certain amount of capital K that can be determined by maximizing the function

$$f(K) = \frac{\Pi}{P} = \left\{\frac{P}{4}\left[1 - c_R\left(1 + f_p c_D K\right)\right]^2 - \frac{1}{\tau_K{}^2 c_{YK}{}^2 P} - \frac{c_R}{\tau_K}\left(1 + f_p c_D K\right)\right\}K. \qquad (28)$$

That this function exhibits a maximum becomes clear by considering the limiting values. At K=0 the profit vanishes identically and in the limit of infinite K the price tends to zero which leads to negative profits. Consequently, a maximum exists for a certain capital value K_M if positive profits are possible at all. It can be anticipated that the firms invest in capital until this maximum is reached and economic growth ceases. However, the development might go beyond the maximum due to distinct competition of firms. Then, the production factors are inefficiently employed but the development comes to a halt at latest when the profits approach zero. In the following this possible further development is ignored and the state at which profit maximizes is assumed as the equilibrium. It is likely that equilibration beyond this state would not lead to qualitatively different conclusions.

The equilibrium state depends on the parameters A_E, c_R, f_P, c_P, c_{YK}, c_D and τ_K whereas the government can only regulate A_E, c_R and f_P. The parameter c_P can be eliminated by introducing the definition

$$A^* \equiv c_P A. \tag{29}$$

Therefore, the only remaining uncontrollable parameters are c_{YK} , τ_K and c_D. The parameter c_{YK} determines the efficiency of the capital production and is for simplicity set identical to c_Y =1. The decay time τ_K describes the time after which capital goods lose their utility and must be replaced. Its value is likely larger than the decay time of consumer goods τ =1. The parameter c_D, that describes the emission during the production process, increases the natural resource usage and pollution of the environment. It would be anticipatory for the government to choose a large value for the pollution tax multiplier f_P. Such a measure would motivate the firm holders to improve their facilities so that they produce less pollution.

Fig. 5 shows various macroeconomic variables at equilibrium as a function of equilibrium assets A_E^*. In the example presented the coefficient c_D has a value that corresponds to a 50% loss of natural resources for a capital value of K=1. Profit Π, price P, wealth as measured by G, Labor L+L_K and natural resource usage Y+Y_K+D increase with increasing A_E^* while capital K reaches a maximum at A_E^*≈1.5. For larger values it is more cost-efficient to invest in additional labor instead of capital since the depreciation and resource tax yield large costs. A low natural resource usage can be realized by decreasing the equilibrium assets A_E^* and thus the wealth G. On the other hand a low wealth G has the advantage of a lower volume of work. The profit has everywhere positive values and, therefore, the operation of this steady-state economy does not disagree with a positive profit rate.

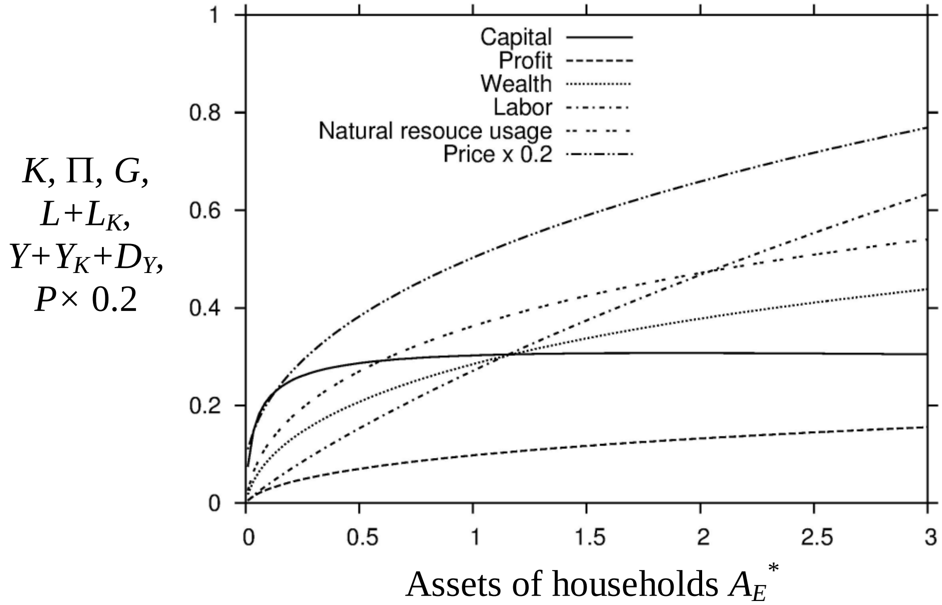

Fig. 5. Capital K, profit Π, amount of consumer goods G (wealth), labor $L+L_K$, natural resource usage $Y+Y_K+D$ and price P as a function of assets $A_E^*=c_P A_E$ at the equilibrium state (for $\tau_K=10$, $c_{YK}=1$, $c_D=0.5$, $c_R=0.1$ and $f_P=10$).

Fig. 6 displays the dependence of various macroeconomic variables on the resource tax parameter c_R at equilibrium for a prescribed wealth (G=0.2). With increasing c_R the total labor and price must increase to maintain the given wealth while capital and natural resource usage decrease. The resource tax measured in real units (T_R/P) does not change much at high c_R values. Therefore, a large resource tax does not automatically guarantee a basic income that suffices for a humane existence. The wealth that can be financed with the tax (by equating real tax with consumption) lies much below G=0.2.[8] However, the basic income could be increased beyond the poverty line by paying it out only if the respective citizen has too low an income. The profit Π is nearly independent of the resource tax parameter c_R. By increasing c_R the capital employed is replaced by labor L since it becomes more cost-efficient when the resource tax rises. This regulation tool facilitates a controlled lowering of the natural resource consumption by the government. How far the resource tax can be raised depends upon the

[8] Note that for $T_R/P \rightarrow G$ the economy has too large a public spending ratio that would lead to a dramatic decrease of the real wage.

added work volume that must be mastered by the community members. Furthermore, the resource tax provokes firm holders to increase their profits by lowering the natural resource usage of their production facilities.

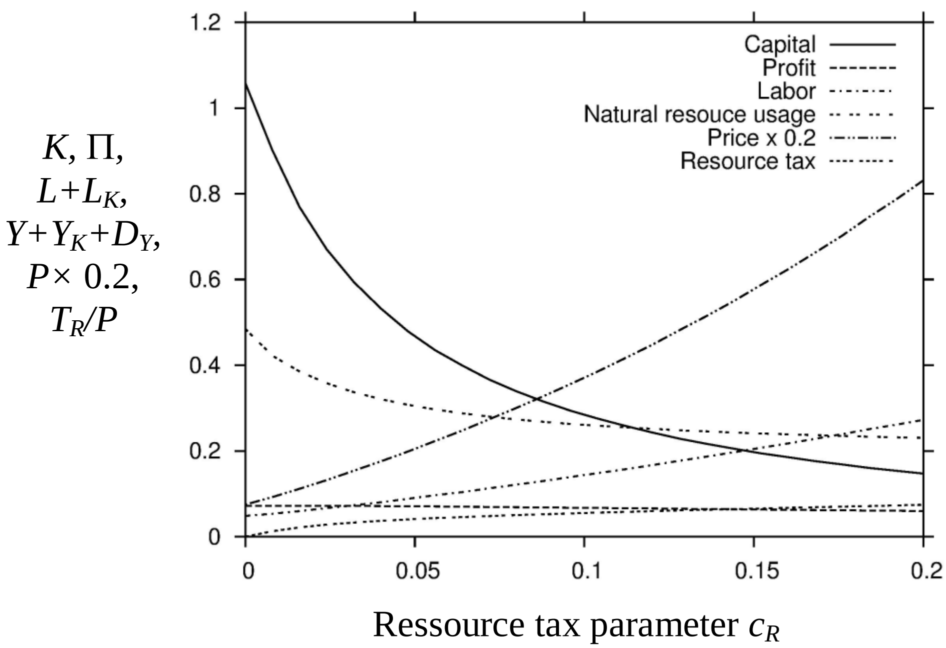

Fig. 6. Capital K, profit Π, labor $L+L_K$, natural resource usage $Y+Y_K+D_Y$, price P and real resource and pollution tax T_R/P as a function of the resource tax parameter c_R at the equilibrium state for a given wealth (G=0.2, τ_K =10, c_{YK} =1, c_D=0.5 and f_P=10).

A policy that allows for a maximization of profits is reached if the public investments are regulated accordingly. An approach for the investment fulfilling this policy is given by

$$I = L_K - L_{KE} = c_{AK}(K_M - K) \quad , \tag{30}$$

where $L_{KE} = K/(\tau_K\, c_{YK})^2$ is the part of labor that has to be financed by the firms and maintains the existing capital. The parameter c_{AK} sets the amount of public investments which eventually contributes to the household assets in terms of wage. Therefore, the government invests until the amount of capital K conforms to the value K_M where the profit maximizes and the economy equilibrates. Then, public investments stop and the labor $L_K = L_{KE}$ is solely dedicated to the maintenance and renovation of existing capital. The firm holders bear the costs of the labor L_{KE} by their earnings. Large public investments may yield too large a volume of work but too low investments possibly result in too slow a development of the equilibrium. However, the firms can also invest on their own by using a part of their profits. This would accelerate the economic development but the equilibrium is not affected since in this state, profits have already maximized.

Applying the aforementioned simplifying assumptions leads to the following dynamical system:

$$\dot{A}^* = c_T\left(A_E^* - A^*\right) + c_{AK}c_P(K_M - K), \qquad (31)$$

$$\dot{G} = (1 - G)\frac{A^*}{P} - G\ , \qquad (32)$$

$$\dot{K} = c_{YK}\sqrt{c_{AK}(K_M - K)K + \frac{K^2}{c_{YK}{}^2\tau_K{}^2}} - \frac{K}{\tau_K}\ . \qquad (33)$$

In these equations the price P results from equation (16) assuming profit maximization and market clearing (W=0):

$$P = \sqrt{\frac{2(1-G)A^*}{K\left[1 - c_R\left(1 + f_p c_D K\right)\right]}}\ . \qquad (34)$$

Equation (33) can be solved independently of the other equations in this system. The solution describes the establishment of the capital value K_M at which the profit maximizes. At least from then on the assets A tends to the equilibrium value A_E due to equation (31). Finally, equation (32) yields the approach of wealth G towards the equilibrium value. This chain of reasoning proves the global stability of the system, that is, the equilibrium state establishes for arbitrary initial conditions. **Fig. 7** shows an example for the economic development. Unlike the present economic system, the alternative system exhibits a system-immanent equilibrium at which the firm profits are positive. The natural resource usage can be regulated since the government determines the distribution of money. The inelasticity of the wage (w=1) guarantees the stability of the price.

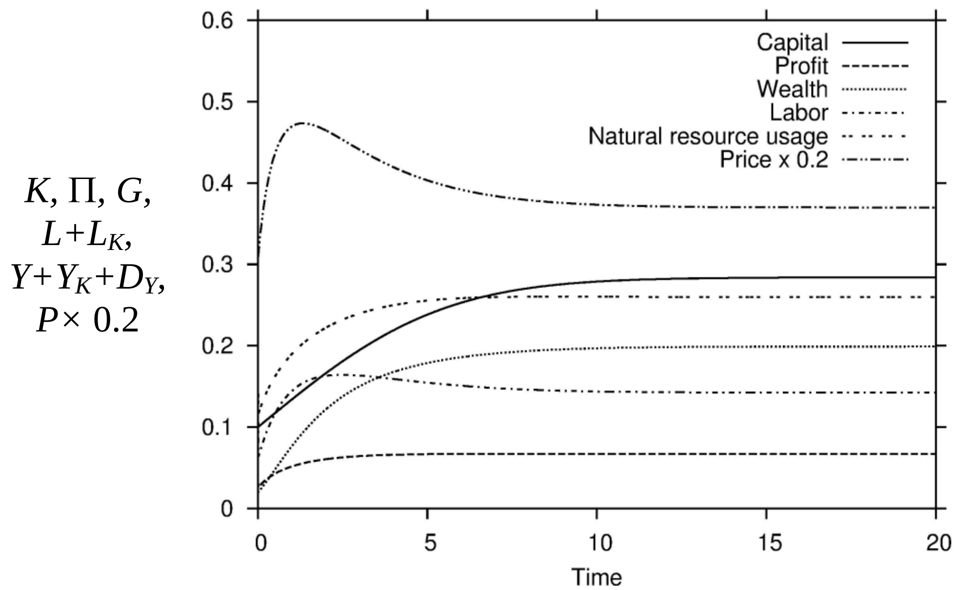

Fig. 7. Example for the macoeconomic development towards the equilibrium (for A_E = 0.46, c_{AK}=0.1, τ_K=10, c_{YK} =1, c_P = c_D=0.5, c_R=0.1 and f_P=10).

5 The wage

The earnings for labor *L* are calculated by *wL*. The minimum wage *w* is prescribed by a constant in the macroeconomic model. However, this does not guarantee a fair distribution of labor. In the current economic system this problem is ignored and, therefore, a part of the wage-related community members remain unemployed. A full employment can simply result from a reduction of working hours. This can be reached by the implementation of two minimum wages (likely sectoral), namely the minimum weekly wage and the minimum hourly wage. The minimum weekly wage (integrated earnings per week) suffices for a below-average lifestyle but is in any case above the poverty line. The minimum hourly wage (wage per hour labor) increases with the weekly hours of working. Division of the minimum weekly wage by the weekly hours of work yields another hourly wage. Then, two curves emerge which are sketched schematically in **Fig. 8**. The optimal weekly working hours result for the employer at the intersection of these curves. It can be expected that the resulting average weekly hours are somewhat above this optimal value. A part of the additional wage for laborers working longer could be subject to an income tax to reduce the disparity of incomes. The flexible regulation of these two minimum wages by the government can lead to full employment regardless of the actual economic situation.

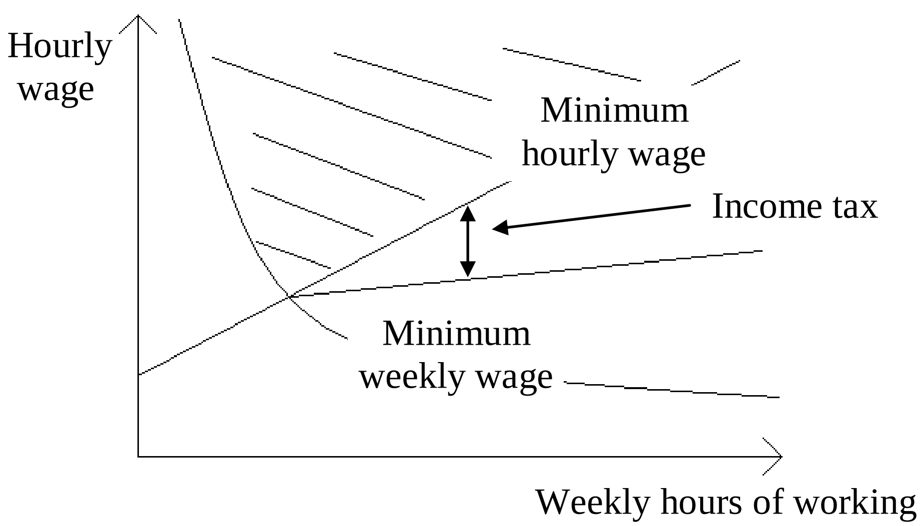

Fig. 8. Regulation of the optimal wage by minimum hourly and minimum weekly wages.

6 Tax on assets

The tax T enables a regulation of the economic system by the government. The government withdraws assets of the households if they are too high on average. On the other hand the households will be financially supported by the government if the assets are too low on average. However, this macroeconomic control does not prevent a very inhomogeneous distribution of assets in the society since households with a large income can save more than households with a low income. A redistribution tax can counteract the tendency to an increasing gap between rich and poor. An income tax may not suffice for this purpose even when it is progressive. This can be understood by considering the budget of a specific household with large income, namely

$$\dot{A}_H = E_H + \Pi_H - C_H - T_H \ , \tag{35}$$

where the index H denotes the specific household. The large income guarantees that $C_H < E_H + \Pi_H$. An income tax has the form $T_H = r_I\,(E_H + \Pi_H)$ where $r_I < 1$. Then, the assets still rise when $C_H < (1 - r_I)(E_H + \Pi_H)$. Since one cannot exclude the occurrence of such a circumstance the inequality might become very large as in the current system and the rising inequality threatens the stability of the economy. However, a tax on assets of the form $T_H = r_A\,A_H$ does not allow the unlimited rise of inequality since the growth of the households assets stops at

$$A_{HE} = (E_H + \Pi_H - C_H) / r_A \ . \tag{36}$$

The tax on assets is raised on individual assets and is evenly distributed among all households. Such a tax can guarantee the basic needs of the community members with low or no income but maintaining the motivation of higher qualified employees and entrepreneurs requires some limitation. Therefore, differences in wealth should exist but in contrast to the present economic system rich people must steadily perform highly qualified work to keep up their wealth. In some sense the redistribution tax can be compared to the “Freigeld” currency that has been proposed by Silvio Gesell (1920). The “Freigeld” loses its value in the course of time in a similar way as assets decrease with the redistribution tax. The government has further duties that could be financed by a tax on assets. These are for example expenses for the administration, the school system, the infrastructure or internal security. These expenses are eventually transferred to the households in terms of a salary for civil services.

7 Conclusion

This paper provides a rough model for an alternative economic system that could lead to a sustainable existence of mankind in the future. It describes a possible transition from the current resource-wasting towards a resource-saving economy. An important feature of the national economy consists in the transfer of the role that banks and private investors play to the democratically legitimated national state. By this measure the growth imperative present in capitalist economies can be overcome.

Sustainability requires that the economy does not depend upon the consumption of non-renewable resources. It is not clear today if mankind can ever reach such a state [see Georgescu-Roegen (1975)]. However, technological progress does justice to this aim in the proposed economy. A limitation of natural resource consumption as well as the resource and pollution tax trigger this kind of technological progress as a result of profit maximization. Furthermore, the limitation of the economy to the national level and the fair distribution of natural resources gradually reduce the inequality between the global North and the global South. Not all questions that may arise could be tackled. It is for example not clear to what extent monopolies play a role in the national economy. To a certain degree monopolies can be avoided by the increasing share of profits with the firm scale because too big a firm becomes less profitable for the entrepreneur by this measure. In the present concept governmental control adjusts the national economy to a given natural resource allocation. On the other hand a system-inherent adjustment could be more advantageous since it bridges the political decision process. Also the transition of the political system was not explained. It cannot be expected that it evolves in all countries at once and the representatives of the current system will probably not accept a change without resistance. Despite these and other open questions, this paper points in a possible direction to overcome the inherent antagonism of the current economic system which cannot be consistent with a sustainable society.

Appendix: Results for a more general model

The macroeconomic model introduced in section 3 becomes more realistic when it includes a larger output elasticity α and an income-dependent consumption function which is given by:

$$C_M = (1-G)\left[A^* + c_I\left(\dot{A} + C_M\right)\right], \tag{37}$$

where c_I ($0 < c_I < 1$) denotes a factor that fixes the income-dependence. c_I should be smaller than 1 since it is unlikely that spending on consumption exceeds the income on average in the limit G=0 and A=0. Note that the original formulation recovers for c_I =0. By solving this equation for C_M one obtains

$$C_M = \frac{(1-G)\left(A^* + c_I \dot{A}\right)}{1 - c_I(1-G)}. \tag{38}$$

At first the influence of the new approach on the equilibrium state is treated. The time derivative of assets vanishes at equilibrium and, therefore, the balance between consumption and depreciation of goods yields:

$$PG = \frac{(1-G)A_E^*}{1 - c_I(1-G)}. \tag{39}$$

The solution of this quadratic equation in G reads

$$G = -\frac{1}{2}\left[\frac{1}{c_I} - 1 + \frac{A_E^*}{c_I P}\right] + \sqrt{\frac{1}{4}\left[\frac{1}{c_I} - 1 + \frac{A_E^*}{c_I P}\right]^2 + \frac{A_E^*}{c_I P}}\,. \tag{40}$$

This solution shows an increase of the consumer goods amount G with increasing equilibrium assets A_E^*.

Cobb and Douglas (1928) based their study on observations and suggested α=3/4 for the output elasticity which obviously exceeds the value used in section 4. Here, α is left unspecified in the first instance to allow for more generality. Then, profit maximization for given capital yields the following volume of labor:

$$L = \left\{ \alpha P \left[1 - c_R \left(1 + f_p c_D K \right) \right] \right\}^{1/(1-\alpha)} K \quad . \tag{41}$$

Again, the labor necessary for restoring capital results from Eq. (18):

$$L_K = \frac{K}{\left(c_{YK} \tau_K \right)^{1/\alpha}} \; . \tag{42}$$

Due to market clearing (W=0) combination of equations (16) and (17) lead together with (41) to:

$$\left\{ \alpha P \left[1 - c_R \left(1 + f_p c_D K \right) \right] \right\}^{\alpha/(1-\alpha)} K = G \, . \tag{43}$$

Combining this equation with the solution (40) for G yields the price P. It results from the following polynomial equation:

$$c_I P^{2\beta+1} + \frac{1}{\left\{ \alpha \left[1 - c_R \left(1 + f_p c_D K \right) \right] \right\}^{\beta} K} \left[\left(1 - c_I \right) P^{\beta+1} + A_E^* P^{\beta} \right] - \frac{A_E^*}{\left\{ \alpha \left[1 - c_R \left(1 + f_p c_D K \right) \right] \right\}^{2\beta} K^2} = 0 \quad , \tag{44}$$

where β=α/(1− α). This polynomial equation has exactly one positive solution since the prefactors in front of the exponentiated prices are positive while the last summand is always negative. Finally, the real profit as a function of capital K yields:

$$f(K)=\frac{\Pi}{P}$$
$$=\left\{(\alpha^{\beta}-\alpha^{\beta/\alpha})\left[1-c_R\left(1+f_p c_D K\right)\right]^{\beta/\alpha}P^{\beta}-\frac{1}{\left(c_{YK}\tau_K\right)^{1/\alpha}P}-\frac{c_R}{\tau_K}\left(1+f_p c_D K\right)\right\}K. \tag{45}$$

The limiting values f (K=0)=0 and $f(K\rightarrow\infty)$=-∞ remain valid even in the more general case.[9] Therefore, for positive profits at least one maximum exists that is decisive for profit maximization, and it is possible to determine the equilibrium state as in the simpler special case. **Fig. 9** displays the various macroeconomic quantities as a function of c_I for c_R=0.1, f_p=10, c_D=0.5, c_{YK}=1, α=0.5 and a given wealth of G=0.2. Obviously, the quantities change only slightly with increasing c_I. The capital K decreases a little while the labor becomes somewhat larger. This comes along with an increase of the price as well as a reduction of natural resource usage. Qualitatively similar results emerge for other output elasticities α. Altogether it can be stated that the income-dependence of the consumption has no dramatic impact on the equilibrium state. The insensitivity of the equilibrium state stability will be proven below.

Fig. 10 shows the macroeconomic quantities as a function of the output elasticity α for c_I =0.5. The amount of capital diminishes significantly with rising α. This is due to the larger income share by labor. Accordingly, the labor increases and the profit as well as natural resource usage decrease. On the other hand the price attains a maximum for an

[9] This can be seen by multiplying the polynomial equation (A8) with K^2P^{-1}. Solving for KP^{β} shows that $KP^{\beta}\rightarrow 0$ for $K\rightarrow 0$ since $P\rightarrow\infty$ for $K\rightarrow 0$. It is also evident that the price approaches zero with increasing K leading to $f(K\rightarrow\infty)$=-∞.

intermediate α. The results reveal sensitivity to output elasticity α but the controllability of the economy remains robust, i.e. the existence of an equilibrium and the dependence on A_E and c_R.

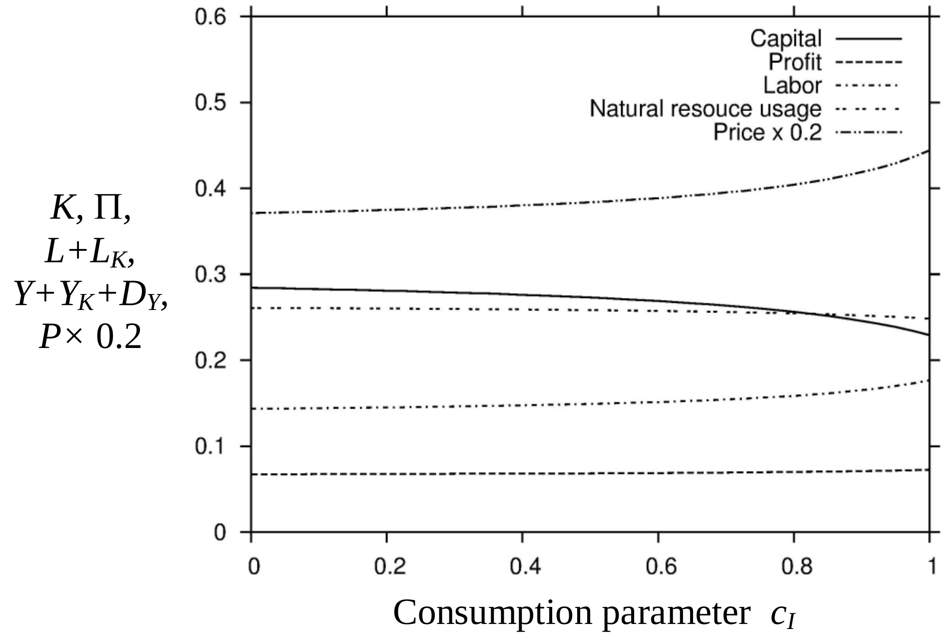

Fig. 9. Capital K, profit Π, labor $L+L_K$, natural resource usage $Y+Y_K+D_Y$ and price P as a function of the consumption parameter c_I at the equilibrium state for a given wealth (α =0.5, G=0.2, τ_K=10, c_{YK} =1, c_D=0.5, c_R=0.1 and f_p=10).

The time development is now governed by the following dynamical system:

$$\dot{A} = c_T\left(A_E - A\right) + c_{AK}(K_M - K)\,, \tag{46}$$

$$\dot{G} = \frac{1}{P}\frac{(1-G)\left[c_P A + c_I c_T\left(A_E - A\right) + c_I c_{AK}(K_M - K)\right]}{1 - c_I(1-G)} - G\,, \tag{47}$$

$$\dot{K} = c_{YK}\left[c_{AK}(K_M - K) + \frac{K}{\left(c_{YK}\tau_K\right)^{1/\alpha}}\right]^{\alpha} K^{1-\alpha} - \frac{K}{\tau_K}\,. \tag{48}$$

The price results again from the assumption of market clearing so that the identity $Y=C_M/P$ holds which yields for the price:

$$P = \left\{ \frac{(1-G)\left[c_P A + c_I c_T \left(A_E - A\right) + c_I c_{AK} (K_M - K)\right]}{\left[1 - c_I \left(1 - G\right)\right] K} \right\}^{1-\alpha} \times$$
$$\times \left\{ \alpha \left[1 - c_R \left(1 + f_p c_D K\right)\right] \right\}^{-\alpha}. \tag{49}$$

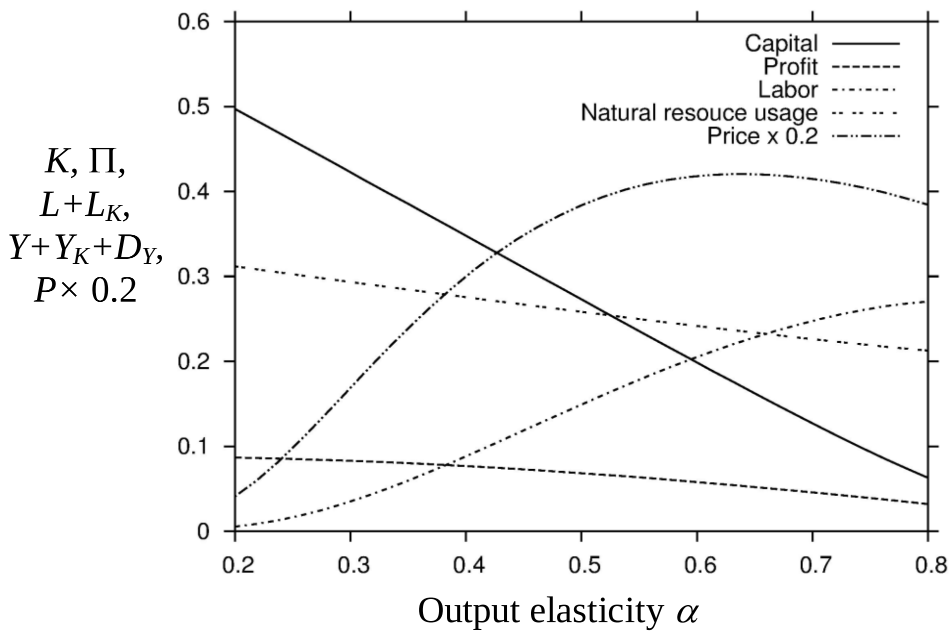

Fig. 10. Capital K, profit Π, labor $L+L_K$, natural resource usage $Y+Y_K+D_Y$ and price P as a function of the output elasticity α for a given wealth (G=0.2, τ_K =10, c_{YK} =1, c_D=0.5, c_I=0.8, c_R=0.1 and f_p=10).

The stability of the equilibrium state can be proven in the same way as for the simpler model. **Fig. 11** shows an example for a macroeconomic development at a large value for the consumption parameter c_I (c_I=0.8) and a more realistic output elasticity (α =0.75). Now, the prices and labor are in contrast to the case c_I=0 (cf. **Fig. 7**) maximal at the beginning of the development. This result occurs because the assets are initially small and the demand depends mainly on income that rises due to the demand itself. The higher demand leads to a faster growth of wealth but also to a larger work volume with a smaller real wage due to the high price. This effect can be dampened by equipping the economy with a larger amount of assets at the beginning. Then, the price does not become as large and, therefore, the real wage does not decline so much. For an exclusive income-dependence of consumption (c_P=0) the government loses the sovereignty to regulate the economics. For example, a decrease of the household assets by the government would be compensated by an increase of the velocity of money. However, it appears very unrealistic that the assets of the households have no impact on their expenditures.

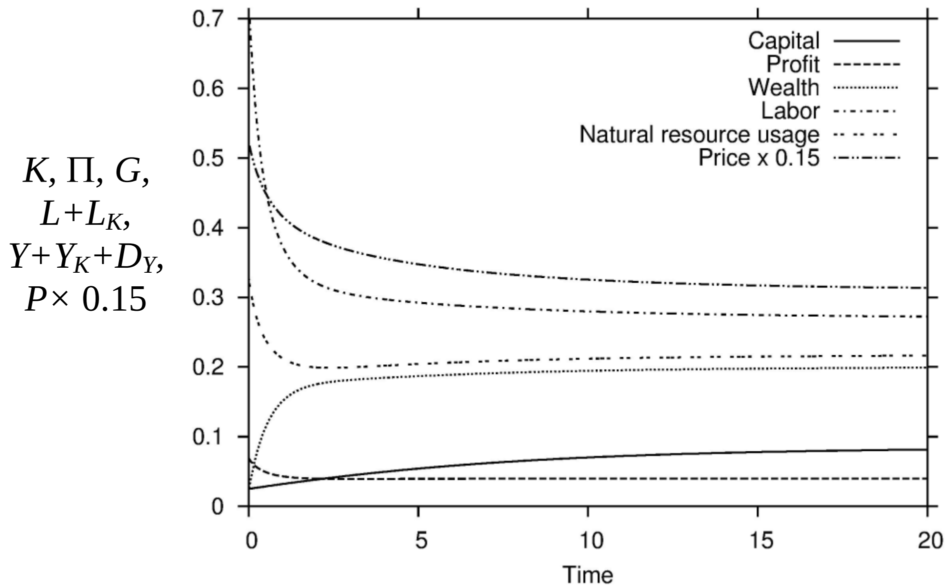

Fig. 11. Example for the macroeconomic development towards the equilibrium in the modified system that considers an income-dependent consumption and α>0.5 (for $A_E^* = 0.187$, α=0.75, c_{AK}=0.1, τ_K=10, c_{YK} =1, c_P = c_D=0.5, c_I=0.8, c_R=0.1 and f_p=10).

References

Barro R. J., X. Sala-i-Martin, 2004, *Economic growth*, Second edition, Cambridge Massachussets, The MIT Press.

Binswanger M., 2009, "Is there a growth imperative in capitalist economies? A circular flow perspective", *Journal of Post Keynesian Economics*, 31(4): 707-727.

Cobb C. W., P.H. Douglas, 1928, "A theory of production", *The American Economic Review*, 18(1): 139-165.

Georgescu-Roegen N., 1975, "Energy and economic myths", *Southern Economic Journal*, 41(3): 347-381.

Gesell S., 1920, *Die Natürliche Wirtschaftsordnung durch Freiland und Freigeld*, 4. Auflage, Rehbrücke bei Berlin, Freiland-Freigeldverlag.

Gossen H. H., 1854, *Entwickelung der Gesetze des menschlichen Verkehrs, und der daraus fließenden Regeln für menschliches Handeln*, Braunschweig, F. Vieweg-Verlag.

Felderer B., S. Homburg, 1992, *Macroeconomics and new macroeconomics*, 2nd edition, Berlin, Springer-Verlag.

Foster, J. B. , 2008, "The financialization of capital and the crisis", *Monthly Review*, 59(11), 1-19.

Keynes J. M., 1936, *The general theory of employment, interest and money*, New York, Harcourt, Brace and Company.

Kremer J., 2012, *Grundlagen der Ökonomie: Geldsysteme, Zinsen, Wachstum und die Polarisierung der Gesellschaft*, Marburg, Metropolis Verlag.

Loehr, D., 2012," The euthanasia of the rentier – A way toward a steady-state economy?", *Ecological Economics*, 84, 232-239.

Marx, K, 1894, *Das Kapital. Buch III: Der Gesamtprocess der kapitalistischen Produktion*, Hamburg, Verlag von Otto Meissner.

Peters A., 1996, *Das Äquivalenz-Prinzip als Grundlage der Global-Ökonomie*, Vaduz, Akademische Verlagsanstalt.

Piketty T., 2014, *Capital in the Twenty-First Century*, Cambridge, Harvard University Press.

Randers J., 2012, *2052: A global forecast for the next forty years*, Vermont, Chelsea Green Publishing Company.

Rodrik D., 2011, *The globalization paradox: Democracy and the future of the world economy*, New York, W.W. Norton.

Scharpf F., 2011, "Monetary union, fiscal crisis and the pre-emption of democracy", *Zeitschrift für Staats- und Europawissenschaften*, 9(2): 163-198.

Solow, R.M., 1956, "A Contribution to the Theory of Economic Growth", *Quarterly Journal of Economics*., 70(1), 65-94.