Future methods of political economy: from Hicks' equation systems to evolutionary macroeconomic simulation

Hanappi, Hardy

University of Technology of Vienna, Institute for mathematical methods in Economics (105-3), vIENNA; aUSTRIA

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Future Methods of Political Economy

From Hicks' Equation Systems to Evolutionary Macroeconomic Simulation[1]

Hardy Hanappi
Email: hanappi@econ.tuwien.ac.at
Homepage: http://www.econ.tuwien.ac.at/hanappi
Institute for Mathematical Methods in Economics
Vienna University of Technology

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> "The sciences do not try to explain, they hardly even try to interpret, they mainly make models. By a model is meant a mathematical construct which, with the addition of certain verbal interpretations describes observed phenomena. The justification of such a mathematical construct is solely and precisely that it is expected to work." [John von Neumann, 1955]

Introduction

Traditional macroeconomics and agent-based simulation (ABS) seem to be two disjunctive worlds, two different sprachspiele in the sense of Wittgenstein. It is not just the fact that macroeconomics has a long and distinguished history that on top of more than 200 years of discourse has recently adopted a sophisticated dynamic mathematical framework, while ABS is still in its infancy and for outsiders looks more like an intellectual toy than a serious research tool. Both languages are tools and eventually both are aiming at the same object of investigation: political economy. Why they let their object appear differently certainly is due to the intrinsic properties of the two languages. As is the case with every tool, the properties of the tool are to some extent transferred to the results that can be achieved with the respective tool. What aggravates this split of work styles is the fact that two different large research communities are linked to the use of the two languages; and each member of such a community has built already a considerable human capital stock, which consists mainly of elements that belong to exactly one of the two languages. Any expedition into the use of the foreign language runs into danger to make a part of the own toolset look obsolete, and thus to lose hard earned human capital. The incentives for cooperation disappear.

To ease the pains of disaggregated research, the aim of this paper is to improve mutual understanding, and to show how far evolutionary macroeconomic simulation can advance political economy by explaining traditional macroeconomics as a (sometimes implausible) special case of its own more general approach. On the other hand ABS researchers often are unaware of the rich interpretative and empirically oriented treasures that classical macroeconomics has in store. What at first sight looks to be easily transferred into an algorithm turns out to be a highly refined argument, which in turn challenges the skills of ABS modelers. The most promising route to follow in the future certainly will be to be versatile in both languages, to walk on both feet. This short paper should provide a modest first step towards this goal.

1. The traditional macroeconomic model (John Hicks)

Conventional economic wisdom teaches that macroeconomics was invented by John Maynard Keynes, [Keynes, 1936], as a reaction to the economic disaster of the Great Depression 1929 to 1934. Closer inspection of the history of economic thought reveals that Keynes in many respects just returns to questions already formulated hundred years earlier by classical political economists. The tightly interwoven fields of economics and political science never had been disentangled in real life; only the economic theories of the marginalist school from 1874 onwards had produced a blind spot with respect to all theoretical elements that went beyond their favorite methodological dogma: methodological individualism. To cure these short-comings of prevailing economic theory and to arrive at aggregate considerations again, Keynes simply transferred the idea of innate properties of physical individuals to larger groups in society. All households in a particular country were inscribed a certain 'propensity to consume', all firm owners were characterized by a 'propensity to invest', and the like. Of course, Keynes was aware that the assumed socio-psychological constants he was constructing would not be constant for a longer period; and this is the reason why he explicitly states that his macroeconomics is a theory of the short-run. Indeed his theory only had to serve as underpinning for short-run intervention of the state in case of emergency, theoretical justification for public investment and credit expansion[2]. Nevertheless Keynes at least had readjusted the focus of economic theory back to a perspective which allowed for heterogeneous aggregate economic agents, in particular including the state.

But Keynes was a model-builder who only used his outstanding skills in rhetoric and prose writing; he never ventured out to the field of mathematical modeling. To popularize Keynes' theory - or what he thought to be Keynes' theory[3] – his colleague Sir John Hicks had invented what he later called a 'class-room gadget': the IS-LM model. For generations of university teachers in economics all over the globe this simple equation system served as the incarnation of what macroeconomics is about. When first shown to John von Neumann by his friend Oskar Morgenstern the latter remarked: "You know, Oskar, if these books (on mathematical economics, H.H.) are unearthed sometime a few hundred years hence, people will not believe that they were written in our time. Rather they will think they are about contemporary with Newton, so primitive is their mathematics. Economics is simply still a million miles away from the state in which an advanced science is, such as physics." [Morgenstern, 1976]. Even today, 77 years after the publication of Keynes' book, the Nobel Prize Winner of last year, Thomas Sargent, did win his Prize for a book which in principle just expands on the IS-LM model [Sargent, 1980]. What is even more important is the fact that most macro-econometric models used today for forecasting and policies consulting still in one way or the other are just enormously extended variants of the demand-driven IS-LM

[2] This earned Keynes an ironic comment from a critical contemporary: His 'general theory' is perhaps useful in special situations, but certainly not general.

[3] Prose texts always are prone to generate rivalry interpretations, in Keynes' case the war on the correct interpretation drags on till today.

model. It thus seems to be an excellent methodological starting point to highlight the features of the ISLM equation system.

In principle just three equilibrium conditions for the flows in three interdependent aggregate markets are postulated: the commodity market, the labor market, and the money market. Briefly consider each of them in more detail.

1.1 The commodity market equilibrium:

$$Y = C + I + G + X - M$$

Total domestic demand consists of the components on the right-hand side, consumption of households (C), investment demand of firms (I), government expenditure (G), and net exports, i.e. exports (X) minus imports (I). The flow equilibrium condition reduces the focus to the description of situations where total demand equals domestic supply (Y), changes of the corresponding stock variables of the right-hand side components are assumed to be zero. Dynamics are added to this equilibrium condition by assuming behavioral equations for demand components, which take into account past values of aggregates. Note that this is the point where fictitious agents - like 'the aggregate of all households' or 'the aggregate of all firms' - are entering the picture and are assumed to possess behavioral traits which can be described by certain functional forms containing psycho-social constants[4]. The most important behavioral function for the ISLM model is the investment function, since it links the first endogenous variable, the interest rate, to investment demand (I). The second endogenous variable is total demand (Y), which in equilibrium is equal to total disposable income[5] of households. On the other hand disposable income received by households can only be used for two purposes; it can either be saved or consumed. Remembering that all stocks are assumed to stay constant, it is clear that savings cannot be added to the stock variable of savings. They have to be a flow variable too. The obvious candidate on the right-hand side of the equation for absorbing the flow of savings is investment demand. But investment demand is already described by an 'independent' investment function that pictures the behavior of the newly introduced agent 'aggregate firms'. The precarious relationship between savings and investment demand therefore will need an adjustment brought about by market forces[6], which change the interest rate and disposable income. The IS-curve is the set of such equilibrium pairs of the two endogenous variables. Economic policy of a state institution can influence the system by changing in particular government

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[4] To identify and to estimate these behavioral equations is the core task of macro-econometrics.

[5] Disposable income is income minus all taxes. In the simplest versions of the model total taxes (T) are assumed to be equal to total government expenditure (G) leaving the corresponding stock variable of government debt unchanged. If the existing (constant) debt is larger than zero, then the interest to be paid for that debt nevertheless will be part of the flow variable government expenditure (G).

[6] This eventually dangerous double determination of investment already reflects Keynes' explanation of possible reasons and remedies for the Great Depression: If (private) investment demand is too low, then government expenditure can step in, either by a temporary increase of a stock variable like government debt, or by influencing investment demand of 'aggregate firms' with lower interest rates brought about by increased money supply (higher credit ceilings). Increasing taxes for those with the highest 'propensity to save' - the rich - would be another, more direct solution that social-democratic Keynesians later proposed.

expenditure (G), which would lead to a shift of the IS-curve in an ISLM diagram. But which point on the IS-curve will be chosen has to be determined by equilibrium forces at another market: the money market.

1.2 The money market equilibrium:

$$\frac{m^S}{P} = M^S = M^D(Y, r) \quad \text{with} \quad \frac{\partial M^D}{\partial Y} > 0, \frac{\partial M^D}{\partial r} < 0$$

The right-hand side of the equilibrium condition again describes aggregate behavior of a fictitious entity, namely all 'money holders' in the economy. They are assumed to be motivated to hold money (M^D) according to two incentives: (1) In case of changing needs for transactions that go along with the size of total demand (Y) the demand for money will change in the same direction (the partial derivative of function M^D is positive). (2) In case of a change in the interest rate money demand will change in the opposite direction (the partial derivative of function M^D is negative), since a change in the interest rate is an incentive to transfer holdings of money into holdings of bonds (a rise of the interest rate), or vice versa (a fall in the interest rate). At this point of Hicks' story it becomes clear that an additional market, namely the bond market, is implicitly involved in the working of the market forces at the money market. It nevertheless remains invisible at first sight because it simply provides a mirror image of the money market enabling market adjustment: Money itself does not carry interest in this story, only the possession of bonds assures a positive interest rate (r). For a fixed real[7] money supply (M^S) the entity 'money holders' can thus decide how much money to hold in the form of bonds, the remaining amount being demand for transaction, called liquidity demand. Evidently there again exists a set of pairs of total income (Y) and interest rate (r), which enables equality between liquidity demand and existing money supply. This is the LM-curve. At the intersection of IS-curve and LM-curve the unique combination of total income and interest rate, which is consistent with the assumption of equilibrium at commodity-, money- and bond-market is determined. The exogenous variable via which the policy-making institution, e.g. a monetary authority, can influence the system here simply is the money supply. So far Hicks' equilibrium model is a story about a well-functioning economy[8]. But so far not much has been said about production and employment. Indeed Keynes innovation – according to Hicks – focusses on the role of demand and money- and bond-market and simply adds the existing marginalist labor market analysis.

[7] The usual introduction of nominal money supply (m^S) and the price level (P) in Hicks' model at this point again hints at the use of the model to explore economic policy issues: Since the central bank is assumed to be able to influence nominal money supply only, the repercussions initiated for the price level (in more sophisticated versions of the model) will alter the impact on the real money supply.

[8] Note that despite the assumption that all variables are measured in real terms, this describes a monetary economy – with money and bonds (compare [Hanappi, 2009] for a detailed discussion). The assumption that in the behavioral equations – and only those are dynamic – agents can correctly derive determine inflation rates, thus use real values, is just that: an assumption about the behavior of a fictitious entity.

1.3 The labor market equilibrium:

$$L^S(\frac{w}{P}) = L^D(\frac{w}{P},\frac{r}{P}) \quad \text{with} \quad \frac{\partial L^S}{\partial \frac{w}{P}} > 0, \frac{\partial L^D}{\partial \frac{w}{P}} < 0, \frac{\partial L^D}{\partial \frac{r}{P}} < 0$$

This equilibrium assumption consists of behavioral equations on both sides. On the left-hand side the fictitious entity 'total work force' is offering hours of labor-time (L^S). A day has 24 hours and only a limited part of it can be offered. This offered amount nevertheless can be thought to be flexible, depending on the relative marginal utilities of leisure time and the marginal utility of the amount of commodities, which can be bought with an additional unit of labor-time sold. With some plausible assumptions on utility functions[9] an increase in real wage will lead to an increase in labor supply (the partial derivative of L^S is positive).

The demand for labor-time by a fictitious 'aggregate of all firms' (L^D) is set by considering profit maximization. The argument starts with the definition of profit (π) at the level of the single firm:

$$\pi = P \cdot X(\tau, L, K) - w \cdot L - r \cdot K$$

Profit is just the residuum after wage cost ($w \cdot L$) and capital cost ($r \cdot K$) have been subtracted from revenues ($P \cdot X(\tau, L, K)$). To determine revenues a so-called production function has to be introduced ($X(\tau, L, K)$), which determines how much physical output (X) is produced by combining a certain amount of labor-time (L) with a given amount of capital (K) using the prevailing technology (τ). To maximize profit the first derivative of π with respect to L has to be zero and the second derivative must be made sure to be negative:

$$\frac{\partial \pi}{\partial L} = P \cdot \frac{\partial X(\tau,L,K)}{\partial L} - w = 0 \quad \text{or} \quad \frac{w}{P} = \frac{\partial X(\tau,L,K)}{\partial L}$$

Profit maximization thus implies that the real wage must be equal to the marginal productivity of labor-time determined by the production function of the firm. Here now again an empirically plausible argument about the shape of production functions sets in, which holds that marginal productivity of additional labor-time is monotonically decreasing. If one accepts this argument then a negative slope for the labor-time demand of a firm with respect to the real wage immediately follows[10].

To justify the aggregation of single firm behavior to an isomorph behavior of a macroeconomic entity and to incorporate the intricacies of the financial implications arising from the simultaneous conditions of optimal capital demand is not a trivial task though. In [Sargent, 1980] this task is achieved though at the price of rather strong restrictions on the

[9] A long (and not too fruitful) discussion of the relationship between the concepts of *utility* and *rationality* has been started since Neumann and Morgenstern provided the first concise formalization of the utility function [Neumann and Morgenstern, 1944]. As Morishima showed, the marginal utility of this dispute is small, since plausibly rational utility functions can easily be added to most different macro-models without changing their dynamics [Morishima, 1973].

[10] An analogous argument for capital demand and the real interest rate can be made.

functional form of production functions, the working of financial markets, and the setting of information and communication requirements.

Restricting attention now to the equilibrium in the labor market, the intersection of labor-time demand and labor-time supply, a certain real wage and a certain employment level (L) will be fixed. Inserting this level of employment in the production function will provide the amount of physical output. Dividing the nominal total supply at the left-hand side of the commodity market equilibrium by this physical total output finally determines the price level. In this way the simplest Keynesian model is closed, all endogenous variables are determined. The exogenous variables fall into two groups: those controlled by state institutions (G and m^S) and those not controlled and used to describe the general economic environment.

Of course, this model has experienced almost infinite extensions and improvements[11], not to speak of the endless debates concerning the question if it really captures what Keynes intended to say.

1.4 The general framework

The structure of the family of dynamic models in the ISLM tradition is straight forward and allows for what is called *comparative dynamics*. The model itself is a difference-differential equation system composed of equations, which are econometrically estimated with historical time series of the geographical region under consideration[12].

Simulation using this model, i.e. assuming that its structure remains valid, typically starts immediately after the last observed year and produces predictions[13] for all endogenous variables. To do so, the future trajectories also have to be specified. This specification usually falls into two groups: The first group concerns exogenous variable which are controlled by economic policy, the second group are exogenous variables, which are not controlled and fall under the category of 'general economic environment'. With different sets of these trajectories different simulation runs can be produced and compared (hence the name comparative dynamics). The most enlightening cornerstones of simulation runs finally are highlighted and are called scenarios.

As already mentioned, in practice the overwhelming majority of economic simulation at a macroeconomic level still follows this methodological approach.

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[11] For an early version of a slightly extended ISLM model that was used to simulate the Austrian economy see [Hanappi, 1983]. A more fine-grained extension combining input-output analysis with a more detailed monetary sector and some global influences on technological progress was presented in another simulation study on the influence of the information sector [Hanappi, 1997].

[12] In this area additional data and new econometric methods probably most progress has been made.

[13] Another rather dubious debate surrounds a postulated difference between *forecasts* and *scenarios*. For some researchers it seems to be important to distinguish between assigning a certain probability to a set of future exogenous, not-controlled variables (forecasts) - or avoiding to do so (scenarios). This has to be strictly kept apart from the measurement of econometric significance of the macro-econometric model, which has always to be provided.

2. Transition to Agent-Based Simulation

In this part some crucial extensions of the basic framework are thoroughly discussed. They build on obvious short-comings of the standard model and try to explore possible changes that on the one hand lead not too far away from standard modeling but on the other hand are courageous enough to point to the desiderata, which agent-based modeling should try to deliver.

2.1 Government debt in a closed system

The large aggregate money flows within a closed system during a given time unit (e.g. a year) can be described with the following circular flow diagram.

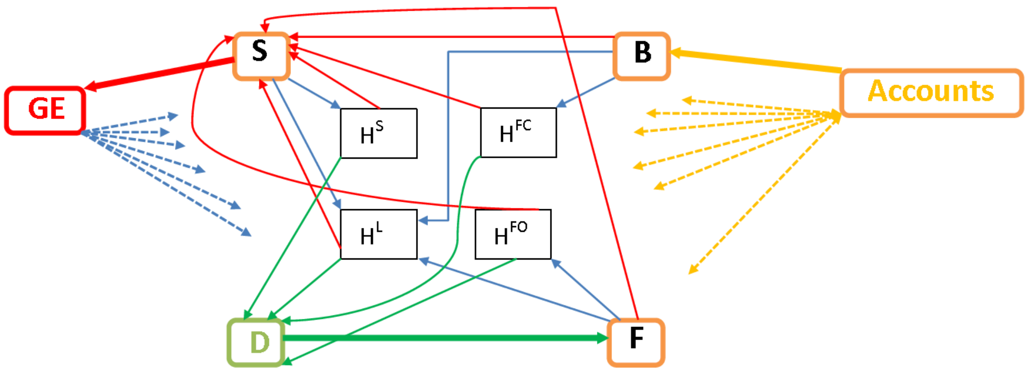

Diagram 1: Monetary flows in a closed economy

This diagram is a substantially enhanced and augmented variant of the circular flow diagrams usually displayed in macroeconomic textbooks, which in turn go back to Quesnay's famous tableau economique.

The households in the centre of diagram 1 are divided into four groups (H^S,H^{FC}, H^{FO}, and H^L) to enable the consideration of explicit class and intra-class conflicts. The households of the labour class are aggregated as H^L, whereas the households of the ruling class are split up into three different fractions: H^{FO} (households of Firm Owners), H^{FC} (households of those who govern the processes of Finance Capital), and H^S (households of those who act as the executive committee of the ruling class on state level).

Furthermore three sets of institutions of the ruling class are distinguished: The set of firms (called 'F', consisting of all means of production), the set of banks (called 'B', consisting of all financial intermediaries including private insurance companies and the like), and the set of state institutions (called 'S', consisting of all public social institutions providing infrastructure for the maintenance of coercive power, e.g. police and law system, for health education standards, for public transport, and the like). These institutions are on a different institutional level than households and always reflect the current state of the class struggle in a very specific way.

The two blue arrows leading from each of these institutions to two different types of households represent the respective wage payments (w^F, w^B, w^S), and corresponding profit flows (π^F, π^B, π^S). Note that in this scheme state institutions are thought to be able to redistribute a part of the overall socially produced profit to their leading executive agents.

The red arrows leading from each household type to the state node indicate taxes (t^L, t^{FO}, t^{FC}, t^S). The other part of state revenues – two more red arrows - comes from taxes collected directly from the institutions (t^F and t^B). Total taxes then are used to be spent on government expenditures (called 'GE' in the diagram). The diverse money flows of government expenditure are displayed as six dotted blue arrows (call them g^L, g^{FO}, g^{FC},g^S, g^F, and g^B), each thought to depict how much is allocated to each of the six possible recipients (H^L, H^{FO}, H^{FC}, H^S, F, B). Since many kinds of infrastructure expenditure are public goods it cannot be directly observed how the different quantities represented by the dotted blue lines should be disentangled. Nevertheless it is conceptually clear and the spent amounts are given in the state's accounting system.

All households are spending the money they receive partly on consumption. The green arrows leading from the households to a node called 'D' (aggregate effective Demand) show that consumption easily can be considered as an anonymous process[14].

Since total consumption represents total revenues of firms (the thick green arrow, call it 'R') firm owners profits can be derived as residual after subtracting all cost (outgoing arrows from node F).

It now only remains to explain the interaction with financial intermediaries, the orange arrows. The central idea is that banks hold accounts of each of the nodes (excluding node D, which is only a didactic device): H^L, H^{FO}, H^{FC}, H^S, F, B, S. For all negative accounts (debts) banks receive income proportional to the interest rate on credits they charge, and on all positive accounts they have cost proportional to the interest rate on savings they have agreed to pay. The dotted orange lines thus have arrows in both directions, they may signal a new credit or withdrawal of saved money as well as new saving or a repayment of an existing debt. Diagram 2 shows a typical situation for a rich OECD country.

[14] This is the entry point for consumption functions, which work with an average 'propensity to consume' of a 'total population'. This so-called 'social-psychological constant' makes income structures disappear. A first critique of this assumption was Kaldor's introduction of two different propensities for workers and firm owners.

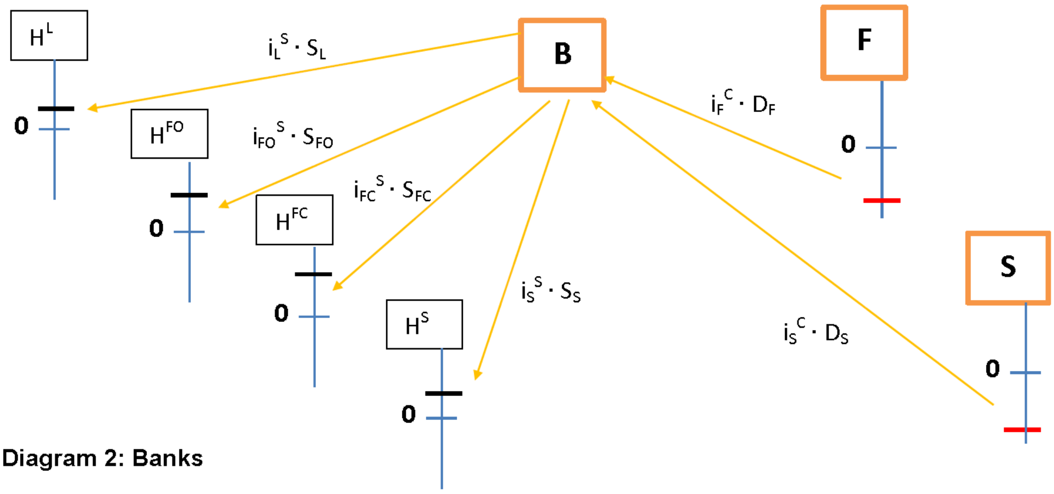

Diagram 2: Banks

The net income of banks stemming from transforming savings of one group into credit for another group therefore crucially depends on the different interest rates it charges for credits (e.g. i_F^C, i_S^C) and the interest rates it offers for savings (e.g. i_L^S, i_{FO}^S, i_{FC}^S, i_S^S). After subtracting from this net income taxes and wages for bank employees, and adding all subsidies banks receive from the state (directly and indirectly via government expenditure) again bank profits of bank owners can be derived as residual. This profit then is the money flow, which will change the money stock of the banking industry itself (not shown in diagram 2). To maximize the relation between this final profit and the already existing (positive) stock of money of financial intermediaries - i.e. to maximize accumulation of this stock – is the goal variable of banks. To a certain extent it contradicts the goal variable of firm owners since its instruments (high interest on credits, low interest on savings) undermine the ratio between firm owners' profits and their accounts (negative D_F, positive S_{FO}) at the banks. 'Finance capital' versus 'industrial capital' has been a permanent conflict between fractions of the ruling class at least since World War 1.

A similar conflict within the ruling class arises between state and banks. Again high interest on credit for public debt (i_S^C) plus low interest on savings (i_S^S) will force on this fraction of the ruling class a reduced income – at least if it is unable to put the burden on the labour force by increasing wage taxes or reducing those government expenditures going mainly to the labour class. In a similar way the fraction of firm owners could defend its profit rate by reducing (real) wages[15], thus increasing exploitation at the level of production units.

The finally discussed node of financial intermediaries therefore highlights class contradictions as well as intra class conflicts. It explains why a *common* action of all fractions of the ruling class to reduce government debt is necessarily leading to class struggle actions, which might shift the income distribution severely in favour of the ruling class. Methodologically this is important for three reasons: (1) It shows that the income distribution is a dependent variable, an epiphenomenon, at best an index showing how far

[15] The role of price-wage dynamics has not been discussed here since in the context of a static review of the circular flows observed ex post it is of minor explanatory power. In a mid-run consideration it certainly can lead to important indices of labour movement influence.

the labour movement was able to get influence on decisions in a capitalist state. (2) The link between flow variables and stock variables in capitalism is always mediated via this node, the stock of social value accumulated at a certain point of time (usually possessed by a fraction of the ruling class) is expressed as a symbol in a sign system (money), which in last consequence is enforced by direct coercive power organized by the state fraction of the ruling class. (3) The scope of a closed system (best imagined as presenting the global political economy) is sufficient for some interesting conclusions (see above), but fails to give any idea about the evolution of political economy. In particular the reasons for a crisis cannot be detected without introducing the time dimension. Additional to the static retrospection of necessary accounting identities during the last observed period the dynamic relations expressing production processes as well as expectation processes governing behaviours have to be included to provide a more adequate picture.

2.2 Inflation and the quantity theory of money

The simplest version of the basic ideas of the quantity theory of money can be described by the following story: Imagine a society, which consists only of two kinds of owners of commodities: those who own commodity A (e.g. 'corn') and those who own commodity B (e.g. 'olives'). The number of owners of group A and group B is equal, and all owners prefer to consume a certain mix of commodities A and B to the consumption of the commodity they possess only. By the choice of qualitative units (e.g. the weight of 'corn' and the volume of olives) of the two commodities the optimal mix can be characterized by a ratio of A to B. For example: 'Everybody likes 2 units of olives with one slice of bread (made with the flower of one unit of corn) best'. To possess this ratio of commodities the two groups have to exchange parts of their possession at a certain exchange ratio, call it *xr*. It means that one unit of A (e.g. 'corn') is planned to be exchanged for *xr* units of B (e.g. two units of 'olives'). Assume further that the group possessing A owns q^A units and the group owning B possesses q^B units, and – to postpone the discussion of excess dynamics – the ratio between q^A and q^B happens to be optimal, i.e. $\frac{q^B}{q^A} = xr$ (in the example *xr*, 'olive units per bread units', is 2). For a given ratio *xr* thus $q^B = xr \cdot q^A$, and the amounts which the commodity owners want to exchange can be $\frac{q^A}{2}$ and $\frac{q^B}{2}$ respectively. Direct barter of this kind would make all owners happy.

But since a quantity theory of money needed to involve money, it had to assume that money exists. Nevertheless it neither explains its emergence nor the forms it can take. At best macroeconomic textbooks mention that money enables a decoupling of direct commodity exchange: Taking money instead of another commodity enables the seller to exchange with somebody who owns money, and who not necessarily owns the commodity the seller needs. For the purpose of describing the quantity theory of money it can safely be ignored how money ownership in the course of social evolution has emerged. All it needs is that the commodity owners possess amounts of money, call them m^A and m^B, which they use to purchase what they do not possess.

And finally the goal of the quantity theory of money, namely to explain the development of prices, needs an argument how prices are emerging. And in this case again, the ignorance with respect to price setting in actually observed markets is surprising: It is assumed that the fixed amount planned by owners of A to be exchanged, $\frac{q^A}{2}$, encounters a fixed amount of money planned by buyers (owners of B), m^B, and exchange takes place! The price of one unit of A then merely has to be calculated as $p^A = \frac{2 \cdot m^B}{q^A}$ and the price of one unit of B in an analogue way will be $p^B = \frac{2 \cdot m^A}{q^B}$.

With these ingredients the main conclusion of the quantity theory of money already is visible. Changing the amount of money (e.g. doubling m^A and m^B) for a given level of output (q^A and q^B constant) will imply a proportional development of prices (e.g. p^A and p^B will also double). To arrive at the formula usually presented in macroeconomic textbooks just one more element is missing: the velocity of money, called *v*. In the simple setting presented it refers to the fact that all money units change hands only once, but one could also assume that exchanges are sequential and the same money units are used more often during the given time interval. If m^A is equal to m^B and money changes hands only once the emerging prices would be the same as in a case where only owners of B have m^B (m^A is zero), change first and thus set m^A to m^B enabling the second step of exchange, with which they get m^B back. In the latter case money changes hands twice and the amount of money needed is only half. This inverse proportionality finally leads to the famous formulation:

$$M \cdot v = P \cdot Y \,,$$

or using the variables already introduced

$$(m^A + m^B) \cdot v = p^A \cdot \frac{q^A}{2} + p^B \cdot \frac{q^B}{2}$$

As the right-hand side of the two formulas show there still remains the problem of computing an overall price index P and a corresponding 'real' amount of quantitative output Y ready for exchange; not to speak of the much deeper problem of what could be counted as money and how it could be aggregated on the left hand side.

It can be doubted that the quantity theory of money would have attracted much attention if it had not been used again and again to underpin strong policy measures. Its strong and implausible assumptions make it a vague construct, and it is exactly this property which opens up a wide range of interpretations. This is also the reason why it has been explain in such detail in the preceding paragraphs: Each of the numerous omissions and inadequate assumptions provides a route to an important insight – and to show this insight is blurred by the on-going use of uncritical variants of this theory. In what follows some of these possible insights are sketched.

First and easiest of all is the idea that evidently a prominent role for exchange of commodities does only make sense if division of labour in society exists. But division of labour implies sophisticated organization on an aggregate level, i.e. a diversity of social institutions. Even tribes of hunters and gatherers were held together by institutionalized rules of behaviour. But in the model of the quantity theory of money there is only one institution, the property right of owners of a commodity; they are assumed to possess something without being challenged and without explanation where it came from and how it is secured.

Second, division of labour within a community necessarily implies that there has to be a common element, which holds together the bundle of commodities and services that is divided. There has to be the idea of social value ascribed by the members of society to each element of this bundle.

Third, combining the former two hidden assumptions, there has to be group – call it the state-fraction of the ruling class – institutionalizing itself by monopolizing coercive power and forcing the latent idea of social value of commodities to become a manifest material sign system, i.e. money. This political (i.e. power centralizing) authority thus becomes the monetary authority, which injects money into the commodity producing society.

The immediate conflict between this state fraction of the ruling class and the fraction extracting surplus via *exploitation* directly during production is unavoidable. It expresses itself as the fight for a division of powers within the ruling class, or in modern terminology: 'for an independent central bank'. And it is based on the fact that a strong enough political ruler can produce money for his soldiers - thus creating exchangeable signs of social value – with which soldiers could buy commodities of all kinds. Since the quantitative amount of output would remain constant, this would imply a rise in prices (the part visible – though distorted - in the quantity of money) but also a redistribution of commodities away from civil society towards 'all the king's men' (the invisible part that motivates the economic policy debate between fractions of the ruling class). From a methodological point of view this is a nice bridge to the next point, namely what is meant by the just introduced concept of *exploitation*.

To answer this, another deficiency of the quantity theory of money is a good starting point: How do prices emerge? Assume that the state fraction of the ruling class can assure that the owners of the means of production (the second fraction of the ruling class) can maintain their possessions and thus are also owners of the commodities produced. In that case the price that these owners can ask for exchanging a unit of their commodity is their instrument variable. The difference between this price and the cost they had to produce this unit is their profit. Considered as aggregate class fraction any exchanges within the group (for any given price level) have to cancel out – one members (seller) profit is equal to another members (buyer) loss – therefore profits of the class fraction cannot arise from exchanges within the class. The only possible strategy for maximizing class profit is to make the difference between price and labour cost as large as possible. This force of class oppression, measured as the ratio of total revenues to wage sum and called surplus rate, is what can be considered as 'exploitation of man by man'. The price mechanism expressed in the quantity theory of money is completely blind in this respect[16].

At the zenith of the upswing of the labour movement, after the victorious Russian revolution and the breakdown of capitalism in the Great Depression, John Maynard Keynes in 1936 clearly saw the need for a revision of the dominant ideological doctrine, the quantity theory of money, in order to save capitalism. Instead of fighting for tight money supply to reduce the share of surplus sucked away by the state fraction injecting new money, he opted for using the price mechanism, i.e. inflation, to reduce the real wages of workers whose nominal wages could be kept constant if union power was broken. This not only is a more sophisticated way to increase exploitation, it also brings into play a new fraction of the ruling class: Financial intermediaries (banks), which could organize a very special type of price level increase by creating credit money for firm owners[17]. By founding their own profit on a share of *expected* future profit of firm owners, this new fraction of the ruling class was allowed to *create* signs of social value, i.e. money, in the presence. What Keynes analysed was already becoming common practice and had been predicted by Rudolf Hilferding in his book 'Das Finanzkapital'. But for economic theory, as always a latecomer, the 'Keynesian revolution' added a new element to the quantity theory of money, namely 'liquidity demand'. An additional conflict within the ruling class was an in-built feature of this proposal. The higher the claim of the banking fraction on future profits (measured as interest rate of credits), the less remains for firm owners – in the future. But in the presence the firm owners can use the new money to improve their exploitation conditions, and the banking fraction just gets paid out of existing profits to acquire a share the existing output – reducing the shares of everybody else. In Keynesian macroeconomic models the dependence of money demand on interest rates, i.e. the formalization of this conflict, dominates the remainder of the quantity theory of money, now called the *transaction demand* for money. During the three decades after 1945 Keynesian macroeconomics managed to become the mainstream of economic theory without ever being forced to make explicit the conflicts between classes and class fractions. The most important element why this was possible seems to be the mathematical language which was used to disguise the political economy to which it referred in the real world.

With the third fraction of the ruling class, financial intermediaries, some new elements of political economy became essential. A credit is a contract, thus a part of the prevailing law system, which in turn is secured by the state monopoly of coercive power. Without a strong enough state fraction of the ruling class no credit banking can take place. Furthermore a credit creates new purchasing power that is an additional claim on *current* output, shrinking

[16] Whatever the state fraction of the ruling class extracts via taxes from owners of means of production is taken from the profit made by exploitation. A common economic program of the ruling class fractions thus has to insist on direct state-organized exploitation with wage-taxes and reduction of government expenditure for the workers. This is part of the permanent sublimate class struggle in OECD countries since 1945.

[17] As an inspection of Keynes writings shows he rather saw the level of credit volume as the essential instrument for monetary policy, and not the money supply. The crude concept of money supply changes was only introduced in later formalizations of Keynes' view by John Hicks. More recently David Romer has started a new initiative to save parts of the Keynes-Hicks IS-LM model [Romer, 2000].

the shares of all those without credit. In other words, credit redistributes purchasing power constituting thus redistributive power of the banking fraction of the ruling class[18]. Summing up the stream of promised future repayment receives the name 'debt', another magical word these days - though it is only the result of a simple arithmetic operation with numbers in contracts. The problem comes with two properties of the expected process: (1) As every future event it might simply not occur, and (2) even if it occurs it is not sure what will constitute social value at a future point of time. To reduce the risk of the bank a further item agreed upon in the contract, called collateral, becomes important. The collateral is something representing social value *in the present*, which could be transferred to the creditor in the case of a failing future repayment. Since in the course of evolution of financial instruments, of securitization (compare (Hanappi & Rengs, 2008)), contracts themselves can be used as collaterals the creation and redistribution of money and purchasing power becomes an extremely fluid process.

But not only the notion of a clear-cut amount of money supply, as it is used in the quantity theory of money, has evaporated in thin air. Also the velocity of money - originally conceptualized as the number of times that a silver coin in one year on the average changes hands – has lost its meaning in the era of electronic sign systems of social value. It indeed is astonishing how an antediluvian theory like the quantity theory of money can invade contemporary comments on the financial crisis. The only explanation might be that behind its veil of simplicity there are vested interests of its user, who aims to address (and to impress) a completely uninformed audience.

2.3 Production and distribution

This part provides a small model to explain how two processes can be understood, which have not been dealt so far.

The first process concerns the neglect of ***dynamic interaction*** that necessarily is assumed in the type of Keynesian macroeconomic accounting schemes like the one presented above. These schemes are derived ex post from empirically observed aggregate flows of money in a certain closed economy during a by-gone year. Any prediction of what will happen next year can build on such a sequence of past events, but it must be clear that this only is possible due to the intervention of model building social agents transforming datasets of past events into sets of ***expectations*** for relevant future variables. Keynes simple assumption in this respect was that large groups in a certain country (e.g. 'consumers') have an innate socio-psychological constant (e.g. a 'propensity to consume') which will stay constant – at least for the next few years. The assumption of socio-psychological constants might serve as a first short-run hint (substituting assumptions on more elaborate expectation formation

[18] This, of course, challenged the state fraction of the ruling class, which used to manage redistribution. Moreover redistribution by credit did not have to observe the feedback from political election processes in democracies. Banks are *private* firms, showing to what their notion of privacy indeed comes up to: Not being forced to consider other goals than the firm's profit maximization.

processes) for highly traditional societies, where neither actual production conditions nor the communication environment change too fast. But for the contemporary global political economy, which experiences a quantum jump in the communication and information environment as well as a dramatic change in production structures, there certainly can be no short-cut assumption on how expectations are formed. So the first task is to show that today social dynamics always have to include a sophisticated view on expectation formation.

The second loose end – closely linked to the first one – is the fact that so far only money flows were considered[19]. There was no link to physical quantities of goods or labour time. Indeed the previous section aimed to destroy the quantity theory of money by showing that its central equation is used to provide an *inadequate* link between quantities exchanged and their monetary mirror image. If this is accepted, then this type of link has vanished – and this creates the need to formulate a ***new link between*** the abstract world of ***money forms and hard physical realities*** of human individuals and their material environment. The evident candidate to formulate this link, of course, is the expectation formation process of social agents! They use their internal models - which are to a large extent based on monetary variables - to choose their actions, which then are actions in the physical economic world. What happens in their mental models (how they look like, how they are exchanged, how they change) is of utmost importance[20].

The nutshell model that follows cannot hope to meet the high aspirations formulated in the last two paragraphs. It can only help to stimulate further theoretical work along its lines. A straight forward starting point is diagram 1. If at the end of a year firm owners formulate and solve their internal models to determine what actions to set in the coming year they base their decisions on expectations. The most important expectations are those concerning exogenous variables (not controlled by the single firm owner) and they usually are predictions of time series of monetary variables (e.g. effective demand, interest rates, taxes, etc.). For firm owners the one essential monetary goal variable is the profit rate, the whole model centres on explaining its future development. So use diagram 1 to describe how it is connected to other monetary flows. In the case of general indebtedness of firms (a usual assumption supported by empirical observation) incoming and outgoing monetary flows of

[19] Keynes again sensed the difficulty: As he emphasized the short-run in the first case ('In the long-run we are all dead.'), he explicitly underlined that all aggregates he considered are in real terms, i.e. all social agents are always perfectly able to transform variables of the world of money into variables in the world of physical interactions. With this tricky assumption, which for certain arguments Keynes could modify, an explicit consideration of price and wage formation could be circumvented. Contrary to the traditional view that equilibrium assumptions are made to provide equilibrium prices based on physical properties of agents (marginal changes of utilities meeting marginal technical production properties) this perspective leads to the view that 'equilibrium' is used as a theoretical short-cut to determine the set of real quantities for given (past) price and wage observations.

[20] Even the economic mainstream seems to recognize the relevance of this issue for today's information society: A recent (2002) Nobel Prize winner, Daniel Kahneman, has concentrated on explaining thought processes used by decision makers (Kahneman et al., 2002). Unfortunately the bad old spell of methodological individualism seduced him to focus mainly on the individual human person.

the firm owners' node are equalized by a change in the corresponding stock variable[21] called firm debt, DB_t^F:

$$R_t + (DB_t^F - DB_{t+1}^F) = P_t^{FO} + W_t^L + T_t^F + i_t^{F,C} \cdot DB_t^F \qquad [1]$$

If revenues from sales (R_t) have been too small to cover total expenditure (right hand side of equation [1]), then the stock of monetary wealth of the firms (DB_t^F) has to be reduced to cover expenses. Total expenditure consists of profits going to firm owners' households (P_t^{FO}), wages and salaries going to labourers' households (W_t^L), net taxes[22] going to the state (T_t^F), and the interest that has to be paid for existing debt ($i_t^{F,C} \cdot DB_t^F$). Note that this simple consideration already includes a dynamic element, namely the fact that the change in the stock variable that takes place at this point of time (at the end of the year) will prevail till the next accounting checkpoint (the end of the next year). During this future period it will change the interest on the expenditure side, and eventually it might hit credit limits that call into question the very existence of a firm – pointing at the role of creditors mediated by another agent, banks.

Now turn to the goal variable profit rate (π_t^F), defined as the ratio between profits (P_t^{FO}) and capital stock (K_t^F):

$$\pi_t^F := \frac{P_t^{FO}}{K_t^F} \qquad [2]$$

In definition [2] capital stock K_t^F has to be a monetary value to enable division[23]. To derive this monetary value, and to understand why the profit rate is a goal variable at all, it is necessary to make a transition to the world of material hardware: In this physical world what appears as monetary value K_t^F might include a factory, or any other kind of production unit, which hardly can be disentangled into the components of which it is composed. In the contemporary (capitalist) mode of production to assign a monetary value to such a production unit thus again is a subtle expectation building process. The essential reason for owning a firm is to have the legal right to employ workers whose labour enables sales, which then turn into revenues as much as possible higher than total cost. A *better* firm therefore is a firm which promises more physical output for given labour input than its competitor. The notion of exploitation thus is already visible on the level of material interactions, but it is difficult to measure: labour time input comes with different qualities; the question how to measure physical output quantity is even more complicated and intriguing. As the practice of capital stock estimates of statistic offices shows certain heuristic procedures have been adopted that mainly take into account the observed past surplus rate and the speed of

[21] A more equilibrium oriented methodology might look at equilibrium forces that drive the system quickly to flow equilibrium instead of admitting changes in stocks. It is evidently impossible to describe accumulation with such an approach, it only allows for consideration of possible equilibrium forces for exogenously given relations between stock owners.

[22] Net taxes are all transfers to the state minus all payments (subsidies) received from the state.

[23] In what follows the role of the labour theory of value is not touched upon and all rates are plainly computed using monetary variables as they actually appear.

(technological) depreciation via innovation that takes place in this segment of the economy. Both elements deserve special attention.

The surplus rate (σ_t^F) is defined as the ratio between surplus (i.e. total revenues R_t^F exceeding wages W_t^L) and these wages:

$$\sigma_t^F := \frac{R_t^F - W_t^L}{W_t^L}, \qquad [3]$$

Last year's surplus rate is taken as an index for how well the exploitation process has worked last year. This evaluation comprises many firm level measures (from maintaining work discipline to successful marketing activities) but also is influenced by general economic conditions (e.g. a general rise in unemployment will drive down wages and for given revenues – e.g. via export sales – increase the surplus rate).

The impact of fast technological progress is rather obvious. Again the argument is immediately visible on a physical level: If a firm introduces a new superior production process[24] this implies that the same work force can provide more physical output. For all other firms using the old technology this means that their exploitation possibilities will decrease, be it e.g. because of a shrinking market share or due to higher wages enforced by the market leader. To measure the physical impact of innovation is only possible at the level of a single firm; again it is only the shadow of the conglomerate of diverse processes on the world of monetary flows, which gives an idea of what is going on. In this case it is the distinction between high growth industries with rapidly increasing labour productivity on the one side, and slowly growing (service) industries with tighter limits to labour productivity increases which can help statistical offices. But why is there a force pushing labour productivity to increase at all?

The fundamental crux of determining the motivation for this has to go back to quantities of goods and time spent again, and has to introduce the notions of power, exploitation and social class. In short, as history vividly shows a certain group within a society (the ruling class) usually is able to use coercive power – or just the threat of using coercive power – to force the rest of society to spend additional time for labour activities, which then materializes as additional goods and services to be consumed by the ruling class[25]. This process is called 'exploitation' and the motive for exploitation is the simple fact that spending time for consumption is preferred to spending time for labour. To work is considered by any ruling class as a disutility, if it has the possibility to force others to work instead of them, then this possibility is exploited. Even the surveillance of the exploitation process early on has been delegated to specially trained (usually less exploited) groups of workers nowadays often called 'managers'. Power in its purest form thus is based on the possibility to do direct physical harm to an individual. Direct coercive power is the bottom line of exploitation. In today's highly organized societies it manifests itself as the power of

[24] The argument for product innovation is in this respect completely analogous.
[25] Compare (Veblen, 1899) for an early historical perspective on the habits of ruling classes.

military and police. In last consequence these are the specialized managers keeping the exploitation process running. Fortunately enough the civilization process of the last two hundred years has been driven by an increasing influence from the social class opposing the ruling class, namely the exploited class, too. Class struggle appearing in many different forms has led to a state administration fraction of the ruling class, which sometimes is inclined to consider a trade-off between lower exploitation for less open conflict, causing frictional cost.

Surplus product in different production units has to be distinguished from surplus in value terms, from money which could be used to buy anything desired. And it is the latter which is most useful for the members of the ruling class. It is the money amount generated by total sales, which characterizes the success of exploitation of a production unit. Two different indices might be used to derive measures that indicate success per unit of input, eliminating direct influence of the size of the production unit. One index is the already discussed surplus rate (σ_t^F), which measures monetary surplus per monetary unit spent for labour time. The second index is the profit rate, which is defined as the ratio between total sales and a monetary value, which the fact of possessing the production unit represents (K_t^F). Again it has already been defined above. The innovative turn of the argument now is that these two dimesionless ratios can be used to construct 'real' economic values for the quantitative growth potential of means of production and labour.

Single owners of production units in principle choose actions that can be summarized in the following three domains: innovation, price setting, and wage setting. The choices in all three areas are highly interdependent and are based on an internal model, which produces expected values of all variables considered to be essential. Moreover the internal models used by firm owners are not only exchanged between them, they also are partially amplified by a media environment that uses most advanced ICT. It is needless to say that a detailed treatment of these processes goes far beyond the scope of this text. What can be concluded here is the following.

Using the terminology of input-output analysis[26] based on quantities (physical technical coefficients[27], $\alpha_t^{i,j}$, and a matrix of labour time input coefficients of different labour quality, $l_t^{k,j}$) the goal to do innovation - and thereby to achieve the highest possible surplus rate – is equivalent either to a reduction of these coefficients weighted by their respective prices and wages (process innovation), or by the introduction of a new row and column in the I-O-matrix which has the property that its surplus rate is higher than the prevailing one

[26] Input-output analysis has its roots in classical political economy (see [Kurz, 2011]) and nowadays is an appropriate analytical tool to grasp the intricate relationships between physical quantities and sign systems. Combined with heterogeneous agent-based simulation techniques it should provide the most valuable tool for political economy.

[27] Extending most conventional interpretations of IO analysis, it here has to be noted that these technical coefficients not only consist of intermediate products produced by other industries, but also natural resources that have to be depleted to produce a unit of production. This becomes important as soon as resources are approaching exhaustion, even if no firms or prices are involved – there are quantitative, physical constraints.

(product innovation). The first set of decisions, innovation decisions, therefore can be expressed as

$$Pgm_t(\alpha_t^{i,j}, l_t^{k,j}) = \begin{Bmatrix} Pgm_{t-1}(\alpha_{t-1}^{i,j}, l_{t-1}^{k,j}) \; if \; Inno_t \leq 0 \\ Pgm_t^*(\alpha_t^{*,i,j}, l_t^{*,k,j}) \; if \; Inno_t > 0 \end{Bmatrix} \quad [4]$$

The new production program[28] will either be the same as in the previous period or will be changed to a new program, $\mathrm{Pgm}_t^*(\alpha_t^{*,i,j}, l_t^{*,k,j})$, depending on the value of the innovation trigger $Inno_t$. A superscript '*' indicates that a variable is an expected variable, expected at the time given in the time subscript. Keeping in mind that a production program introduced like this leads to a well-specified physical amount of output units ($x_t \; or \; x_t^*$), the pivotal element $Inno_t^f$ for a certain firm f can be described as follows.

$$Inno_t^f = \frac{p_t^{*,f} \cdot x_t^* - w_t^{*,k,j} \cdot l_t^{*,k,j} - p_t^{*,i,j} \cdot \alpha_t^{*,i,j}}{w_t^{*,k,j} \cdot l_t^{*,k,j}} - \frac{p_t^{**,f} \cdot x_{t-1} - w_t^{**,k,j} \cdot l_{t-1}^{k,j} - p_t^{**,i,j} \cdot \alpha_{t-1}^{i,j}}{w_t^{**,k,j} \cdot l_{t-1}^{k,j}} \quad [5]$$

All variables of the first term on the right-hand side, the price-wage system (of the whole economy) as well as the physical variables are expected values derived from an internal mental model describing the economy – an internal model not further specified here. The second term on the right hand side describes the surplus rate that is to be expected if physical properties of the production program are left unchanged. Note that the price-wage variables to be expected are not remaining constant but now are assuming different expected values, superscript '**', than in the first term. Again the expectation formation process has to remain in the black box in this text[29]. Taking heterogeneous physical innovation possibilities serious, at any point in time there will be a certain non-empty subset of firms doing innovation. Since the second term also contains expected values influenced by other firms actions it may well occur that many firms are forced by general developments to innovate (swarming effect) or may also be hindered to carry out already pending innovations by the current context (from stagnation to depression). Since all price-wage decisions are set by agents using mental models, the role of real variables is limited to the role they play in these models. Nevertheless their size can be derived at each point in time. And as they are reported via public and private media, e.g. the number of people without employment, or CO_2 emissions, they might exert a feedback on expectation formation.

[28] A production program (an algorithm) substitutes and improves the notion of a production function used in conventional economic theory.

[29] It evidently has to be formalized as a rather complicated strategic game implying irreversibility of time. As Ping Chen writes 'For academic economists, a fundamental shift in theoretical tastes is essential for the advancement of economic science. In the era of complexity science, we have the rare chance to find an analytical solution for non-linear systems. Computer simulation and graphic representation will play an increasing role in theoretical and empirical analysis.' [Chen, 2010, chapter 2.6.1]. Inspiration on how to proceed can also be found in [Prigogine, 2003, pp. 22-44].

Without the underpinnings of a full-fledged agent-based model translating these micro- and meso-level ideas[30] into aggregate macro-dynamic elements is a daring task. Nevertheless the following hypothesis concerning the expectation formation process of firm owners seems to be plausible. First define the aggregate innovation potential of the all firms' $INNV_t$:

$$INNV_t := \frac{\sum_{Inno_t^f > 0}(\omega_t^f + \rho_t^f)}{\sum_f(\omega_t^f + \rho_t^f)} \qquad [6]$$

This potential is the share of innovative firms ($Inno_t^f > 0$) in all firms, where each firm is weighted by the sum of its employment share (ω_t^f) and its share in revenues (ρ_t^f). Evidently this is a dimensionless number, with $INNV_t \in [0,1]$, and it takes care of physical size (using employment shares) as well as monetary size (using revenue shares) of firms.

Then define the aggregate price level P_t and the aggregate wage level W_t in a similar way:

$$P_t := \frac{1}{\sum_f(\omega_t^f + \rho_t^f)} \cdot \sum_f(\omega_t^f + \rho_t^f) \cdot p_t^f \qquad [7]$$

and

$$W_t := \frac{1}{\sum_f(\omega_t^f + \rho_t^f)} \cdot \sum_f(\omega_t^f + \rho_t^f) \cdot w_t^f \qquad [8]$$

Remember that these three aggregate variables are determined by the interaction of firm owners, who set them for their own firm, using their own internal model-building, which in turn is exposed to general media influence as well as local communication. At the end of this section these definitions will be used to form several hypotheses about aggregate behaviour.

But before that can be done a last big step in this nutshell model, namely the interaction between firm owner decisions and decisions at other nodes has to be envisaged. Quite generally the division of tasks between the different nodes of the network of the ruling class can be characterized rather simply: The state fraction has to provide stability by administering the part of the surplus necessary for infrastructure and maintenance of the monopoly of coercive power (police, law system, ideological power); while the finance fraction specializes in exploring new innovation possibilities, providing savings it administers (private and public) for promising entrepreneurial activity across different parts of the global economy. Referring to the diagrams in 2.1, the state's dynamic behaviour thus works via taxes and public expenditures, while finance capital works via savings and credits.

For aggregate macrodynamics the following definitions for the instruments of the state fraction of the ruling class are proposed: There are four essential elements, the level of government income flows (all forms of taxes) T_t, the level of government expenditure flows G_t, the structure of the income flow (wage tax as a share of total tax, tax_t^W), and the

[30] A more fine-grained discussion of the importance of the meso-level occupied by meso-institutions, as e.g. proposed by [Dopfer et al, 2004], goes beyond the scope of this text.

structure of expenditure flows (expenditure for coercive measures as a share of total expenditure, g_t^{cm}). Using again diagram 1:

$$T_t := T_t^F + T_t^B + T_t^{H^L} + T_t^{H^{FO}} + T_t^{H^{FC}} + T_t^{H^S} \qquad [9]$$

Flows coming from sales or acquisitions of state-owned property are not considered in [9]. Such flows would only occur as a change of state savings at the bank account of the state.

To follow the traces of class politics with respect to exploitation - a task implied by the arguments in the previous paragraphs - it is necessary to add an additional essential variable, namely the wage tax rate tax_t^W:

$$tax_t^W := \frac{T_t^{H^L}}{T_t} \qquad [10]$$

With this tax rate the state fraction of the ruling class can control what remains from gross wage income of workers as net income, thereby influencing the downward pressure on wages that can be exerted by the other fractions, firm owners and banks (e.g. via the interest rate on consumer credit).

$$G_t := G_t^F + G_t^B + G_t^{H^L} + G_t^{H^{FO}} + G_t^{H^{FC}} + G_t^{H^S} + G_t^u \qquad [11]$$

Government expenditure for infrastructure (including different types of public goods) is lumped together in variable G_t^u (unspecified government expenditure). The other variables on the right hand side of [11] are just the flows that can be assigned to the recipients as indicated in the superscript.

A crucial part for the understanding of activities of the capitalist state fraction is to recognize the distinction between expenditures to increase coercive exploitation measures, G_t^{cm} (e.g. certain kinds of domestic police and military units) and other expenditures on infrastructure (G_t^{is}) reflecting the increasing usefulness of public goods in ever more interdependent societies. Though the borderline between these two types in many cases is blurred, not to speak of the empirical coverage by official statistical units, the theoretical distinction is of utmost importance. In the context of this nutshell model it is simply assumed that the share of coercive measures is defined as

$$g_t^{cm} := \frac{G_t^{cm}}{G_t} \quad \text{with} \quad G_t^u = G_t^{cm} + G_t^{is} \qquad [12]$$

Given the monopoly of the state to exert coercive power this distinction has a further consequence: the possibility for the state fraction of the ruling class to ***deepen existing contradictions***. With respect to external expansion this refers to developments from nation states to world-wide (colonial or post-colonial) empires with different rules of the game in different political districts. With respect to internal policies this refers to (legal and policed) segregations in the working class. In both cases stronger exploitation of the politically weakest group can be used to calm down disturbing aspirations of the strongest exploited group. Deepening exploitation of the weakest discriminated element has become a policy element vital for the survival of capitalism since the late 19th century, when the British working class was admitted some improved conditions that fierce colonial exploitation made possible. More recently post-colonial exploitation via exchange rate deterioration has prolonged the viability of global capitalism. With respect to internal deepening of exploitation ethnic segregation (e.g. in rich oil countries like Saudi Arabia) and gender exploitation have played a similar role[31].

The finance fraction of the ruling class determines interest rates for savings and credits of the other aggregated players (compare diagram 2). Profits of banks (P_t^B) can be determined by calculating the difference between incoming (total revenues R_t^B) and outgoing money flows (wages of bank employees W_t^B, and taxes paid by banks T_t^B) collected by private households of bank owners.

$$P_t^B := R_t^B - W_t^B - T_t^B \qquad [13]$$

Once profit arrives in node H_t^{FC} (see diagram 1), a profit rate of the banking sector can be computed

$$\pi_t^B := \frac{P_t^B}{K_t^B} \qquad [14]$$

Since banking is just a service - the provision of an amount of money either before (credit) or after (savings) another amount of money has been transferred to the bank – physical capital plays a much more remote role; the amount K_t^B from an economic perspective is even harder to approximate than in the case of firms.

Ignoring many institutional details the basic revenue generating mechanism can be described in the following way (compare diagram 2):

$$R_t^B = \left(i_t^{c,F} \cdot WT_t^F + i_t^{c,S} \cdot WT_t^S + i_t^{c,H} \cdot WT_t^H\right) - \left(i_t^{s,H} \cdot WT_t^H + i_t^{s,B} \cdot WT_t^B\right) \qquad [15]$$

The banking sectors revenues are the difference between the cost of attracting savings (the interest paid for savings, interest rate $i_t^{s,\cdot}$ times the respective wealth of the saving entity $WT_t^{\cdot}$) and the money received for redistributing these savings as credits (interest rates $i_t^{c,\cdot}$paid for debts measured as a negative value of wealth $WT_t^{\cdot}$). In [15] there are several implicit assumptions to be explained. As national statistics show, the standard circuit of flows in OECD countries after WW2 is characterized by positive savings of the household sector, which then is redistributed as credits to firms. Thus there has been a traditional dominance of the first element of the first term ($i_t^{c,F} \cdot WT_t^F$) and the first element of the second term ($i_t^{s,H} \cdot WT_t^H$) in [15].

[31] For the use of the concept of 'diversity' in the capitalist 'managerial' context compare [Hanappi-Egger, 2011].

In a more general way Joseph Schumpeter - following in this respect Karl Marx[32] - had even considered this mechanism as an element of the core of the capitalist mode of production: Because entrepreneurs are promising to be able to pay back a high interest to their creditors they are forced to increase labour productivity not only by more coercive labour conditions, but also by new production processes and new products. The latter two by-products are the justification for capitalism as a necessary era in human evolution. And finance plays a central role by choosing whom to give credit! For Schumpeter it was evident that only those firm owners are entrepreneurs and should earn a positive profit, which are able to increase labour productivity. The financial intermediary that selected these entrepreneurs should then receive a share of the increased profit rate derived from successful innovation. What today is sometimes called investment banking therefore has a noble historical background in political economy. But as any other historic episode this heroic phase of capitalism has to end someday – and again this idea was shared by Marx and Schumpeter. As history showed both had the timing wrong, capitalism is alive – though its original tenet to increase global labour productivity hardly can be performed any more by the same type of entrepreneurial entity that inspired Schumpeter. The contradictions between global needs and the promise of quick and high profit rate expectations of private entrepreneurs (e.g. problems of effective demand, necessary long-run horizons for educational goals, consideration of environmental constraints, tailoring solutions to regional needs) have exploded. Today It is more and more evident that large-scale innovation in the world economy has to be a political task not to be left to the profit maximizing considerations of private financial firms.

Having said this, it nevertheless becomes clear that a new democratic process, which can substitute old style global investment banking, is needed. Its discussion goes beyond the scope of this sub-chapter. But what in any case follows is that the activities of the banking sector will have to be split: One part will have to take care of the biggest investment problems of the planet (former large-scale investment banking), and the other part should manage the less demanding tasks of handling a global currency, or a web of connected local currencies – including all types of borrowing.

The important idea for this second set of mechanisms is that it is aiming at enabling reproduction instead of enabling growth of a money stock, vulgo capital accumulation. This split of financial intermediation – reproduction versus growth – is already visible in equation [15]. Indeed the fact that today the credits paid by states (which are social institutions responsible for reproduction) to private banks ($i_t^{c,S} \cdot WT_t^S$ in [15]) are part of the revenues of these banks expresses a dominance of the global financial intermediaries, which in a disastrous way forces nation states into firm-like behaviour. States are treated by big finance like firms: 'Innovate and grow, or perish!' Of course, it is not feasible to erase Greece from

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[32] Since Marx wrote more than half a century earlier than Schumpeter he did not see the possibility of positive savings of better-of worker households in richer countries. The modern macroeconomic tools of deepening conflicts in one direction in order to calm down the clashes of class struggles in another domain were not fully visible in the mid-19th century. But the positive role of capitalism in human history due to productivity increases certainly is a common issue emphasized by both, Marx and Schumpeter.

Europe's map because some parallel to firm bankruptcy is proclaimed by creditor banks. The physically existing reality will prevail, and the symbolic interaction taking place between the social classes (and the different fractions of the ruling class) will have to adjust.

As a consequence the nutshell model will not include equation [15], but will instead propose two other equations taking care for the two roles of financial intermediaries that just were mentioned.

First, the role of detecting global needs and allocating financial resources to be done by public global banking:

$$INV_t^{global} = \alpha_t \cdot \sum_{cty} \beta_t^{cty} \cdot G_t^{is} \qquad [16]$$

The importance of necessary global needs is being expressed by parameter α_t , and the respective contribution of each country (out of its infrastructure expenditures G_t^{is}) is then adjusted by weights β_t^{cty}, which should express how much a country is able to contribute, and how much it is concerned by the problem[33].

Second, the role of administering continental money management with predetermined interest structures for local lending and saving, which just reflect administration cost at wage levels in the range of employees with similar education levels in other parts of the (European) economy. This typically would be the role of the ECB and its affiliates.

$$\left(i_t^{c,F} \cdot WT_t^F + i_t^{c,S} \cdot WT_t^S + i_t^{c,H} \cdot WT_t^H\right) = i_{t-1}^{s,H} \cdot WT_{t-1}^H + i_{t-1}^{s,B} \cdot WT_{t-1}^B + w_t^B \qquad [17]$$

Equation [17] expresses the proposal that money attracted by the (public) administrative banking sector in period $t-1$ should be paid back in the next period (or with the same procedure in any later period) with an interest rate on credits, which also covers the cost of administration w_t^B. Since the bank is not a private firm any more profits are zero, and there is no incentive to treat nation states like indebted firms; rather there is the common objective to enable reproduction.

Putting together the parts of this nutshell model is easy and difficult at the same time. It is easy because all of the quasi-physical formulations of 'natural laws of economics' used in mainstream neo-classical theory are not used, and cannot burden a search for a 'quasi-natural equilibrium growth path' of the economy. All that is used from standard macroeconomics is the accounting framework that describes necessary ex-post relations between monetary aggregates. After using these definitorial relationships the remaining variables are considered to be determined, to be set, by the agents constituting the political economy.

What, on the other hand, makes the approach extremely complicated is that agents make their choice with the help of an internal model, which they maintain, communicate, and continuously update. The core of the actual interaction that takes place thus is intricately

[33] The simple form of [16] hides a complicated political process.

interwoven with expectation formation processes. Since each internal model used by an agent is an example of what Herbert Simon [Simon, 1982] has called 'bounded rationality' – it is a subjectively zoomed projection of what really is going on – there is no hope for a closed mathematical analysis unless bounded rationality is replaced by omniscient representative agents[34]. It is the inevitable complexity of such a model, which leads to the necessity to use heuristically enriched *agent-based simulation*.

Nevertheless an agent's internal model-building process could be approached by applying the old Newtonian framework, which was so successful in the natural sciences: Changes in essential variables are functions of the state of these variables, or

$$\dot{\xi} = f(\xi). \qquad [18]$$

The dotted time derivative[35] of the vector of essential variables ξ is assumed to be a function f of the current state values of these variables. An eternally correct function f therefore waits to be discovered, and as soon as this is done all future development can be deduced. Boundedly rational agents might believe in the existence of such a function, but not knowing it would result in the use of simple approximations. The simplest way to do so is to use linear approximations of the partial derivatives of the arguments of f in [18]. Using discrete time, a possible part of the internal model of firms might thus look as follows:

$$INNV_t^* = \alpha_{INNV,t} \cdot \xi_t$$

$$\text{with} \quad \xi_t := (INNV_t, P_t, W_t, T_t, G_t, tax_t^W, g_t^{cm}, i_t^{c,F}, i_t^{c,S}, i_t^{c,H}, i_t^{s,H}, i_t^{s,B}) . \qquad [19]$$

The parameter vector $\alpha_{INNV,t}$ is of the same length as the vector of essential state variables ξ_t and is empirically estimated. It approximates how much a change of this variables would influence the expected aggregated innovation activity $INNV_t^*$. If more arguments change then the simplest first approximation would just add up all influences; but of course more sophisticated heuristic behaviours can be postulated. Another analogous parameter vector can be assumed for all other instruments to be set by a certain agent, and finally the consideration of all these proxies as a simultaneous system will lead to the possibility to determine a best choice of the agent's decision set.

Indeed, experiments with such agent-based simulations have been performed and the more or less continuous decline of labour productivity growth in Europe since 1945 could easily be modelled. But there is more to report than just the application of Newtonian methods to bounded rationality.

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[34] Such an assumption, of course, would immediately spoil the entire scientific enterprise because if no knowledge accumulation is necessary, then no science would have ever been emerging. Such a 'rational expectations'-approach therefore is itself completely irrational.

[35] Note that in the natural sciences the assumption of continuous time usually is preferred to discrete time, a choice which is non-trivial. In the social sciences – and evolutionary theory in general – the need for at least two different essential time ranges suggests a preference for the assumption of a discrete time line. For details of this argument see [Hanappi, 2013].

The most interesting part of re-telling economic history by the use of this formal model stems from the fact that each essential variable only makes sense as long as it stays within a finite interval: the innovation force $INNV_t$ is between zero and one; the price level is bounded below by wages and interest rates and upwards has to considered upper limits described by monopolistic competition; the range of tax rates is limited by basic infrastructural needs and maximum possible tax revenues; interest rates can only extract a part of the profits generated by firms and on the other hand need a minimum interest on households' savings to attract money to provide credits, etc. Most important, the real physical quantities derived from symbolically determined actions in the monetary sphere do have borderlines of feasibility: minimum food consumption, heating and health conditions linked to the unemployment rate, environmental deterioration, and the like. The countervailing forces between agents realized by the setting of their instruments in times of relative stability of a political regime will lead to highly irregular trajectories, some variables sometimes getting very close to their borders but then being repelled by instruments set according to re-estimated values of the $\propto$-parameters. These controlled irregular movements are the correlate of what mainstream theory usually calls business cycle theory. Contrary to the standard view in the latter, divergence – and not convergence – of essential variables is the rule. It is only the switch of expectation formation (sensitivity borders have to be made explicit, taking into account amplifiers of the communication environment) expressed by re-estimated $\propto$-parameters, which for some time guarantees the relative stability of the regime. Nevertheless there is a high probability that after a somewhat longer time period the system gets stuck with numerous essential variables hitting limits and expectation models being unable to develop sufficient repelling force. This is a state of deep crisis calling for a change of political regime.

At this point it is the set of essential variables itself, which has to change. For the current crisis the proposal made for global financial intermediation (see [16] and [17]) is a typical blueprint for an element of such a regime change. What has been proposed as a mid-run strategy for the 4th commandment in [Hanappi, 2012][36] is another example of an element of a new regime. How a change of the parameter set is to be carried out, the revolutionary dynamics needed in the physical domain can certainly not be explained by the same modelling framework that was used for the old relatively stable regime. There has to be a second class of models generalizing issues of revolutionary dynamics. A generalization of this kind - finding similarities in social processes that transform societies which have been relatively stable for many decades, even centuries – has not received sufficient theoretical attention yet. And of course the constant features of such a generalized model of revolutionary dynamics at the same time might provide some insight into the slow long-run progress characterized by the changing features.

[36] The 4th commandment developed in this text is: 'No unemployment is the prime goal of European economic policy'. The change in labor organization needed to achieve this goal is so incompatible with the current state of affairs that it implies indeed a new type of European governance.

The slow dynamics of regime change are a central methodological ingredient of evolutionary theory. Only by modelling the opposition and interaction between slow and fast dynamics the evolution of living entities can be fully understood. It is clear that this topic goes far beyond the brief exposition of a nutshell model helping to explain the evolution of economic theory from 20th century macroeconomics to 21st century agent-based macro-simulation.

3. Further Perspectives

Full-fledged agent-based simulation on a macroeconomic level goes one big step further than the reformulations proposed in the previous chapter. It has to start by newly defining the agents that have to be modeled. The reason is that one of the major deficiencies of standard modeling was its historically inherited inability to give an adequate picture of the strong linkages between agents in different nation states (the globalization problem) as well as the important overlapping connections between economic and political agents (the political economy problem). Moreover the importance of agents, even their emergence and extinction, is changing with accelerating speed in recent decades. This makes an even more daring goal for ABS a necessary ingredient: To start to explain how institutions emerge and vanish[37]. But before going into its dynamics, the list of existing agents has to be produced.

The next step is to provide a first sketch how these agents are connected. This comes up to an exercise in network analysis using techniques for collecting and evaluating large amounts of ever more available data. The model-builder in this stage has to take on the role of an artist to design the essentials as well as the limits of such a network.

Once the first prototype of the network exists one can start to think about the internal model building process of the major agents. In general it will not be possible to infer the properties of these internal models (what is perceived, how models are built, what they look like, how they are used, etc.) by interviewing human representatives. Again the artistic skill of the researcher and knowledge about what surfaces in the actual political economy process has to substitute for much of the traditional empirical methods. Instead of well-defined internal models of agents, there often will be only *plausible* (suggested by empirical observations) guesses concerning the partial derivatives of the agent's reactions on events it observes.

The link to standard macroeconomics typically concerns the choice of agents:

An obvious aggregate entity is the conglomerate of firms in a certain country. It makes sense to divide this group into three different agents[38], namely small and medium sized enterprises (SMEs), transnational corporations (TNCs) and financial intermediaries (banks). The behavioral equations in standard macroeconomics which describe firm behavior usually are the investment function and the labor demand function. Moreover firm behavior is implicit

[37] How acute this issue is shows the current state of the European Union (see [Hanappi, 2012]).
[38] For a more detailed argument see [Hanappi, 2012, appendix A4].

in the assumptions on price and output determination[39]. In most standard macroeconomic models price setting power and the employment consequences of private property of the means of production are assumed away by postulating the existence of perfect competition in commodity- and labor-markets. To transfer these two powerful instruments to a newly invented agent called 'the (perfectly competitive) market' is an implausible and ideologically motivated short-cut. A further important decision of firms concerns innovation. Standard macroeconomics, when enlarged to macroeconomic growth models, first considered aggregate technical progress only as exogenous, as manna falling from heaven. More recently at least substitution between labor-time used for production and labor-time used to increase productivity of production is taken care of (compare [Aghion and Howitt, 1998]). With ABS all these five instruments (investment, labor demand, price, output, and innovation) can be formalized as explicit actions in the program representing the respective firm group (SMEs, TNCs, banks). Since national borders play an important role for firms, each action also can be specified and distinguished with respect to geographical location. The much more detailed generalization of standard macroeconomics, which is enabled by ABS, of course also has its price: Full specification of all possible links would be an enormous – and unnecessary – task, and as a consequence the work of the model designer is to eliminate many possibilities, which are considered to be inessential. This model-building activity often has to resemble an artistic project rather than scientific work based on empirical observation.

The second large agent is the set of households in a country; again from the point of view of ABS it has to be divided in several groups. On the one hand the grouping can follow split of employers (different firms, employees and bosses, plus state and international institutions) augmented by the groups of the young, the retired, and those doing reproductive work at home. In standard macroeconomics all their instruments are usually collapsed into an aggregate consumption function. Their leisure-work behavior again is hidden by strong assumptions on the power of a fictitious new agent, the perfectly competitive labor market. The link to demographically important decisions (education period, children, retirement period, etc.) in standard macroeconomics usually is completely out of focus (compare [Hanappi and Hanappi-Egger, 2009]). Another important area of instruments of household concerns the link to financial intermediaries. Recent decades have seen a diversification of possible actions of what used to be the simple choice of 'consume or save' in standard macroeconomics. In particular this area increasingly allows acting across national borders. The challenges and difficulties for ABS already mentioned in the previous paragraph apply again.

Third, political institutions have to be brought into the picture by ABS. No other area has been so crudely modeled in standard macroeconomics, which implies that for the new modelers' generation there is a wide undiscovered land. This room to move has its dangers too: Model-builders easily can get lost in all the institutional details surrounding the law

[39] Early critics of this view from inside the Keynesian camp have been Edward Chamberlin [Chamberlin, 1933] and Joan Robinson [Robinson, 1933]. Their impact on standard model-building remained very limited.

systems that are responsible to regulate – or to pretend to regulate – this area. The most important intervention of ABS in this field certainly is to free macroeconomics from the 'Procrustes bed' of restricting instruments of political agents to the Keynesian ideas on fiscal- and monetary policy[40]. Two main sets of activities should be distinguished: On the political level the ***central function of political entities*** – as opposed to capitalist firms - is to ***stabilize reproduction***[41], while on ***an evolutionary ascending scale*** political entities have to be designed to allow for ***changes towards more democratic self-governance***[42]. With respect to the latter the flourishing development of (formal, partly game theoretic) literature on voting theory as well as other theoretical input from political sciences might be drawn upon to enhance ABS. in this respect the mission of ABS to help with respect to a new synthesis of the social sciences becomes particularly visible. The interaction of well-structured political entities seems to be extraordinary difficult to mimic in ABS. On this research frontier current modeling often is still only producing prototypes of archetypical network evolution that shall resemble political organization. While political entities traditionally were thought of only setting a more or less fixed and stable framework within which economic agents then are following their goals, the recently observed increase of extremely tight connections between political and economic actions (e.g. activities of TNCs and national economic policies) question the traditional view. The almost complete blinding out of political entities by standard macroeconomics thus can be understood as a historical fact, but makes less and less sense for today's world. And again, like with the other agent modeling generalizations, the task ahead of ABS is enormous.

And this task does not stop at identifying the diverse macroeconomic agents. Once a proposal for such a network is made, the next step is to bring it to life by adding internal model building to each of the nodes. Internal model building consists of several steps: perception, feeding new data to the model, maintenance of the model (including communication and eventual innovation), and deduction of actions derived from the internal model (compare [Hanappi, 2011]). Conception and computational demands are again tremendous and to start with the sparsest settings cannot be avoided. But keeping in mind that model-builders in biology (e.g. brain modeling) already are successfully developing large-scale models at the cutting-edge of computer technology any too pessimist attitude of social scientists[43] should forbid itself. The future of evolutionary modeling is out there waiting for the next generation of transdisciplinarily educated scientists to explore it.

[40] Compare [Hanappi, 2004].

[41] The distinction between capitalist firms and (democratic) states is a central issue in [Hanappi, 2012].

[42] Self-governance of quickly enlarging political entities (e.g. from national units to continental units) necessarily increases the danger of bureaucratic impasse and misuse, e.g. bribery and hold-up cost. A vast new literature on these phenomena (e.g. [Krause and Meier, 2003]) might well be considered for ABS modeling.

[43] The organization structure of globally working research teams in the social sciences will certainly be a major hurdle to be taken soon. The current individualistic, journal-oriented academic culture dominated by tradition preserving editors is doing more harm to scientific progress as is commonly understood.

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