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Knowledge Directed Economic Selection and Growth[1]

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Abstract *The single most important postulate in economics is* what you assume about the totality of all possible states that the economy can be in *(the state space). The assumption you make determines the costs of information and learning when exploring that state space, the nature of the equilibrating forces of the markets of the economy, towards what kind of equilibrium the economic system is heading and what that means for the modes of behavior of individuals and firms, in short the dynamics of the economy. The mainstream model of economics assumes a very narrow and, for all practical purposes, fully transparent state space and thus excludes all interesting dynamics from the analysis by assumption. I argue for the alternative assumption of a very large and non-transparent state space, or investment opportunities space that takes us into the unpredictable world of an* Experimentally Organized Economy *that is more compatible with economic reality. In that brave new world of economics new answers to old questions appear. Above all, using the tools of analysis developed from, and for the mainstream neoclassical model to study the realities of an EOE will place the analyst in a misinformation situation. I illustrate that through simulation on the Swedish micro to macro (MM) model and with one Swedish business case.*

Keywords: competence bloc; economic mistakes; economic dynamics; Experimentally Organized Economy; Stockholm School; tacit knowledge; transactions costs

The Limiting Concept of an Equilibrium

The notion of an equilibrium runs through the history of science. Its definition in economic theory has, however, been borrowed from physical sciences. With that came a convenient mathematical tool, but not the best concept of an equilibrium.

As defined, economics has got a peculiar notion of an equilibrium since it abstracts from the possibility of (1) influencing it (*exogeneity*), from (2) how to reach it (*dynamics*) and from (3) the possibility that it may not exist as postulated as an operating domain of the economy. As in celestial mathematics this imported definition implies that whatever individuals do they cannot influence heaven. It is

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exogenously determined. When in equilibrium, individuals and business actors rest, as satisfied as they can be, on the 'lit de parade' that an exogenous equilibrium represents. They don't want to move. Try to explain that idea of a business situation to a man of business and he will look like a big question mark.

To change that situation you have either to assume the existence of a heavenly influence or a central Godfather/Policy Maker that is beyond anybody's control. I have disliked this definition of an economic equilibrium since I began doing serious economics and argued for a change.[2] The definition we have handicaps theoretical development in economics and it excludes by assumption, and therefore prevents a systematic understanding of economic dynamics.

In this paper I therefore disassociate myself from the standard notion of an exogenous equilibrium and from the notion of incapable individuals that is embodied in the mainstream Walras–Arrow–Debreu (WAD) model of economics, its associated prior assumptions, and the thinking that comes with it, that together preclude the possibility (again by prior assumption) that individuals or entrepreneurs can influence the course of macroeconomic events. These are also notions that can be found in Marxian structuralism.

To change this thinking in a more realistic direction we have to come up with a better notion of equilibrium than what can be borrowed from celestial mathematics or statical mechanics, because some notion of an equilibrium is needed even in economics. There is not space in this paper to work out an alternative formal definition, but I will argue at the end of this essay that the notion of stability is more interesting than the common fix point or steady state equilibrium and, as a consequence, the definition of an equilibrium has to be derived from a concept of welfare that we may not be familiar with.

I will not be arguing that we give up mathematics. Mathematics generally defined has an important role to play in economics, but the mathematics we need for the kind of analysis I find necessary is different. And the priors imposed on economic models to guarantee the existence of an exogenous equilibrium come back to you as part of the empirical results when the models are econometrically estimated. Distorted information and analytical 'misinformation systems'[3] are therefore part of the information or knowledge story I am about to tell. And alternative numerical methods for economic analysis also exist that are fully capable of accommodating what we need, for instance mathematical simulation.

The Investment Opportunities Space

This first great problem of economic theory has to do with its single most important postulate, namely *what you assume about the totality of all possible states that the economy can be in* (the state space or investment opportunities set). The *second* most important problem is how much of that totality, at any point in time, that anybody can know or learn about. The *third* problem, now reduced to theoretical familiarity, is to what extent that knowledge (information) is reliably reflected in market prices that often are your only guide in decisions related to the future.

So this is what I will do. First I will present a grumbling repeat of the shortcomings of the standard static equilibrium model of economics, but I will say OK, under the assumptions made the WAD equilibrium model clarifies the principal nature of markets (in static equilibrium) as an economic information system (mathematical duality theory). The same model also serves as a useful econometric measuring instrument.

Then I will modify (only slightly) some of the most embarrassing prior assumptions of the WAD model to come up with the more broadly defined theory of what I call the theory of an *Experimentally Organized Economy (EOE)* in which the mainstream model figures as a special case. Ideally, in doing so[4] I should obtain a dynamic version of the WAD or perfect competition model.

Even though we are in the midst of an information revolution far more dramatic than that which Lamberton[5] foresaw, I will follow him and depart from the common usage in mainstream economic theory of the term information as synonymous with knowledge. My story will be about the use of tacit knowledge, intermediated through markets and within hierarchies, rather than coded knowledge (information) communicated by wire. With that, Knight's[6] concept of uncertainty as distinct from calculable risks comes back to life, and the theory (of an EOE) may be capable of even accommodating live entrepreneurs.

Finally I will illustrate what this means for individual behavior and economic/business decision making with simulation experiments on a model approximation of the EOE, and with a business case.

Duality in a Zero Transactions Costs Linear Economy (No Selection)

The mainstream WAD model has been a great intellectual achievement that has spellbound even its most ardent critics; and there is no need to abandon that achievement to go on, only to modify some assumptions of that particular model. The most critical intellectual limitations of the WAD model are its assumption of: (1) a very narrow and transparent state space or business opportunities space; and (2) that this state space can be explored at zero, or almost so, transactions costs such that a full information overview of the entire state space is obtained and the rational decision maker only has one optimal choice to make.

The way it has been done is clever. Assume strict convexity of utility and production sets and continuity in the derivatives. Under these assumptions a price vector that clears all markets can be determined, and with that also a static exogenous equilibrium. This is the representation of the economic landscape WAD stands for. If correct empirically there is no problem. Exploring the state space so construed (by assumption) means that as long as you travel at a positive angle (upwards) *at no cost* you will inevitably reach the peak.[7]

This is OK as a provisional assumption for particular inquiries, but if you depart from the given assumptions to achieve improved relevance you come up against difficult mathematical modeling problems. Under the assumptions mentioned, an ingenious method of economic measurement has, however, been developed. Much econometric research rests in one way or another on that model, and even if its prior assumptions are awkward, the results can be interpreted. In exogenous static equilibrium, furthermore, mathematical duality theory holds and prices contain all the information needed to determine quantities (structures), and vice versa, quantities tell everything about prices. Dale Jorgenson and his research group have made a point of using mathematical duality theory to redefine, measure and interpret, for instance, the national accounts.[8]

Strict convexity in some longer term sense is, of course, natural to assume, but not the way it is formally done in the WAD model. So give up on some of the 'strictness' and skip the continuity assumptions (this is not trivial) and we will enter a non-linear world where positive transactions costs in the form of non random business mistakes will appear, together with non-clearing markets.

A Stylized Representation of What We Need

My story will probably be most easily understood if I first relate it to a stochastic version of the neoclassical WAD model as it appears in statistical learning literature[9] or subsets thereof, such as rational expectations or efficient market theory. The following assumptions define that model:[10]

1. Agents maximize expected utility—MAX(U).
2. Expectations are formed from subjective probability distributions conditioned by 'all available information' (Ω), that is historic realizations of all stochastic variables—EXP(X)=$P(X|\Omega)$.
3. Agents form (from Assumptions 1 and 2) actual ex post probability distributions that are identical to the subjective probability distributions conditional on Ω under Assumption 2.
   EX POST $P(X)\equiv P(X|\Omega)$.
4. EX POST $P(X)$ are stationary.[11]

This is a stylized version of the neoclassical WAD model, formulated on a rational expectations mode, as it appears in modern financial (efficient market) and learning theory.

Assumption 4 is a needed assumption for economic ('econometric') learning, something made clear already by Havelmoo.[12] It imposes equilibrium on the model, but market clearing will only be feasible under certain nice specifications of the model. A steady stream of observations from the realization of $P(X)$ will eventually, and with the precision desired, allow an unbiased estimate of the parameters of the distribution $P(X)$.

This connects the market as an economic information system in equilibrium (duality theory) with the WAD model as an economic measurement model; but economics is more than static measurement. It is also concerned with understanding dynamics.

Introducing the Experimentally Organized Economy and Growth through Economic Selection

Assumption 3 above hides the fundamental equilibrium conditions of the WAD model that have to be given up if you want to allow individual agents to explore state space at a cost, to come up with unexpected discoveries, to learn more than was embodied in Ω and to influence the course of macro economic events. In no way, states Assumption 3 will the search for information [read: attempts to estimate the parameters of $P(X)$] change the distribution function $P(X)$. Ex ante is always equal to ex post, barring a randomly distributed difference term.

Ex ante and ex post distribution functions define the state space of the WAD model. Changes in state space are occasioned by *events*,[13] defined as changes in the set of available information or shifts in the conditional probability distribution ($P[X|\Omega]$ to $P[X|\Omega^*]$) and agents quickly, and at no cost, learn the parameters of the new probability distribution $P(X|\Omega^*)$. Efficient markets are assumed to immediately return the ex ante, ex post distributions to a stationary distribution. This leaves no room to discover new opportunities, or for the Schumpeterian innovator or entrepreneur, who changes the parameters of the system. There may be room for a Kirznerian trader or entrepreneur as an assumed hidden actor (an invisible

hand), who equilibrates the system after it has been perturbed, but only if his equilibrating performance draws no resources.

Under this assumption of stationarity calculable risks prevail and business mistakes appear as mathematically insurable. There is no distinction to be made between risk and uncertainty and between information and knowledge as is also the case in 'modern' financial economics. Knight considered such notions ridiculous.[14] Under Knightian uncertainty plans and outcomes normally differ in expectation. Business mistakes are *not* random and insurable.

The notion that ex ante ex post differences may define a non-stochastic (non-stationary) process came out of Wicksellian and Stockholm School economics.[15] On this Wicksell,[16] in formulating his cumulative process, came up with the interesting insight that has been washed out of WAD economics that ex ante may differ systematically from ex post and that such systematic differences may constitute the core of dynamics, i.e.:

$$P\,(\text{Ex ante–Exp post}) = \text{non-stochastic process (non-stationary process)}.$$

We have to consider the existence of a *realization function*, a term coined by Modigliani and Cohen[17] the parameters of which can be determined and from which agents can learn about what went (unexpectedly) right or wrong.

If you define non-stochastic economic mistakes as transactions costs, and the most important transactions costs, the economic modeling world changes radically.[18] In what follows I will make non-random economic mistakes (non-stationarity) define the demarcation line between, on the one hand the WAD model (with stochastic mistakes that leave the structure of the model unchanged) and, on the other hand, the theory of the EOE in which business mistakes are systematic, non-stochastic and structure changing. In one way this is very close to Dahlman's[19] discussion of economic externality, the conclusion of which is that the only transactions costs left to compare are resource losses due to imperfect information or uncertainty, note (my comment) uncertainty in the Knightian (op.cit. 1921) sense.[20]

Learning and Positive or Negative Selection Bias

Ex ante ex post differences in the stochastic WAD model follow a stationary process and contain no information. Agents know everything that can be learned.[21] When the differences are non-stationary there is something to learn from the differences. If learning is costless, as it is in statistical learning theory,[22] the information will be incorporated in the model which will immediately again become a stationary process. But learning is not costless. It draws significant resources, not least in the form of business mistakes.

When the assumed state space or business opportunities space has been expanded sufficiently to become non-transparent for all individual actors, *uncertainty* exists as distinct from *calculable risks* and there is something to learn from exploring the state space at a cost, making mistakes along the way and learning from them.

Learning by definition now means that the state space may expand and the agents of the model may together even be expanding state space at such a rate that state space increases faster than its rate of exploration and that *we are becoming increasingly ignorant about all that can be learnt*. It is an empirical question whether

this—I have called it *the Särimner*[23] *information paradox*—is the case, or whether exploration and learning will eventually exhaust the growing state space, in which case it will eventually be fully known and the theory of the EOE has collapsed back into the WAD model.

In an EOE, however, *competence bloc* theory (Table 1) is needed to understand the outcome of the exploration, learning and selection process. The competence bloc is an organizational design that intermediates tacit knowledge over markets or within hierarchies between actors that create, identify and commercialize winning new technologies. Decision making and learning is now ruled by the sequences of considerations in Table 2, and the subject matter to be learned about (item 6) becomes dependent on the economic process. There is no longer an exogenous equilibrium. Statistical learning is no longer reliable since costs in the form of non-random business mistakes unavoidably occur and perturb the equilibrium.

To understand this suppose

$$Y = \sum \alpha x + \varepsilon$$

defines what you have to know to draw a winning ticket (business success). Here ε is a random white noise flow. You have statistical data on historic Y and x. The critical assumption is that on the ε. You now have a traditional econometric measurement system and a statistical learning system. If the (linear) $Y=F(x)$ function defines a stationary process over time, as statistical data are collected you obtain unbiased estimates on the parameter vector $\{\alpha\}$, and with any precision you may desire. This is statistical learning.[24]

Table 1. Actors in the competence bloc

Item	
1.	Competent and active *customers*
2.	*Innovators* who integrate technologies in new ways
3.	*Entrepreneurs* who identify profitable innovations
4.	*Competent venture capitalists* who recognize and finance the entrepreneurs
5.	*Exit markets* that facilitate ownership change
6.	*Industrialists* who take successful innovations to industrial scale production

Source: G. Eliasson and Å. Eliasson, 'The biotechnological competence bloc', *Revue d'Economie Industrielle*, 78, 4, Trimestre, 1996.

Table 2. Competence specification of the experimentally organized firm

Item		
Orientation	1.	Sense of direction (business intuition)
	2.	Risk willing
Selection	3.	Efficient identification of mistakes
	4.	Effective correction of mistakes
Operation	5.	Efficient coordination
	6.	Efficient learning feedback to (1)

Source: G. Eliasson, *Firm Objectives, Controls and Organization—The Use of Information and the Transfer of Knowledge Within the Firm*, Kluwer Academic Publishers, Boston/Dordrecht/London, 1996, p. 56.

If, on the other hand learning affects the {α} vector the standard assumption on ε won't hold up. Estimating it will give a biased representation of the {ε} vector. We are now in EOE territory. Market clearing does not occur and the reliability of learning feedback from item 6 to item 1 in Table 2 is affected.

Knowledge Accumulation Through Learning Feedback

To understand why the decision sequence of Table 2 and the competence bloc are needed in the theory of the EOE, but not in the WAD model, we have to begin with the axiomatic comparison of the two models in Table 3.

With state space very large and non-transparent rather than the opposite (item 1 in Table 3) agent behavior will be characterized by bounded rationality in Herbert Simon's[25] sense and difficult to communicate tacit knowledge[26] and intuition will have to guide decisions. *Intuition means* (my definition)[27] *that agents can make up their minds intuitively on the basis of a much larger knowledge base than they are capable of explicitly accounting for and explain to outsiders.* Their decisions will therefore be considered very risk prone to outsiders (item 2 in Table 2), even though they are not to them.

Business mistakes will, however, be an expected experience and rational decision makers will have to be prepared to deal with them. Modern information and decision systems in firms are therefore organized for efficient identification and effective correction of mistakes (items 3 and 4 in Table 2).[28] When a winner has finally been identified, and is being moved up to industrial scale production and distribution, coordination (item 5) sets in, and the final question (item 6) is *to what extent this success story can be reliably stored as experience and fed back into the next round of the decision process* (item 1).

The question (I repeat) is to what extent the decision sequence through the six items in the table will converge onto a fully informed situation of the kind assumed in statistical learning, meaning that repeated learning through the decision sequence of Table 2 will make agents increasingly more informed and eventually fully informed. In the WAD model with an external equilibrium (a fix point) and zero learning (transactions) costs this is the case. If convergence occurs (assumed) costless learning will take us back to the fully informed situation of the stationary WAD model. The actors will then be facing an analytic statistical learning situation.

If the costly decision process of Table 2 constantly and through learning changes what you learn about (the equilibrium is not exogenous) and constantly makes learning feedback under item 6 an unreliable input in the next business decision round, the agents will find themselves in Särimner Viking territory facing

Table 3. The axiomatic structure of the WAD and the EOE models

Item		
1.	State space:	very small and transparent or enormous and nowhere fully transparent
2.	Behavior dominated by:	bounded rationality tacit knowledge intuition
3.	Institutions that regulate access to state space:	free or less free entry

Source: G. Eliasson, *Firm Objectives, Controls and Organization—The Use of Information and the Transfer of Knowledge Within the Firm*, Kluwer Academic Publishers, Boston/Dordrecht/London, 1996, p. 24.

a non-analytic business situation. Analytic methods become correspondingly unreliable.

You now need competence bloc theory to explain the selection process.

Competence Bloc Theory

Innovation supply (item 2 in Table 1) may occur spontaneously in the market or as a deliberate response to a perceived customer demand. Some researchers believe that innovation supply is stochastic. Probably not. In the longer run there will never be better technologies/products than there are customers who understand how to use them, appreciate their functionalities and are willing to pay (item 1). If customers get involved in the innovation supply decision a more sophisticated determination is called for. Competence bloc theory attends to that.

The identification, capturing and commercialization of winning innovations are always conducted in an elaborate sequence of assessments conducted by specialized *commercializing agents* (the entrepreneur, the venture capitalist, the agents of the private equity market and the industrialists) that together make up the important part of the competence bloc (actor categories 3–6). Identifying winning innovations (technologies) and commercializing them is a resource using process fraught with business mistakes that is more or less missing in the literature.[29] It should definitely not be thought of as a stationary process.

The more capable the actors in the competence bloc to perform their commercializing tasks the more positively biased in the direction of selecting winners the competence bloc will be. For this to occur the competence bloc has to be *vertically complete*. One agent group missing (for instance industrially competent venture capitalists) and the selection process may come to a halt. One actor of each kind, furthermore, is not sufficient. *Horizontal variety* in competence is needed which means that each category has to be represented by a large number of actors.

It is reasonable to assume that the creative innovation supply is (much) more broadly defined than the experienced based commercialization process. Hence there will always be a loss of winners, and positive transactions costs in the form of lost winners to consider.[30]

When the competence bloc is vertically complete and horizontally sufficiently varied critical mass has been reached and the risk of losing winners minimized. The stage is now set for an endogenous Schumpeterian type creative destruction process of endogenous growth of the kind stylized in Table 4. Innovative entry now occurs in response to

Table 4. The four mechanisms of Schumpeterian creative destruction and economic growth

Item	
1.	*Innovative entry*
	enforces (through competition)
2.	*Reorganization*
3.	*Rationalization*
	or
4.	*Exit* (shut down)

Source: G. Eliasson, 'Företagens, institutionernas och marknadernas roll i Sveriges ekonomiska kris' ('The role of the firm, institutions and markets in the Swedish economic crisis'), Bilaga 6 in *Nya villkor för ekonomi och politik*, Ekonomikommissionens förslag, SOU, 1993, 16, pp. 195–233.

perceived customer preferences and profit opportunities (item 2 in Table 1). A positive selection bias has been instituted, feedback of experience (item 6 in Table 2) to the next decision (item 1), even though still unreliable has been improved and faster endogenous growth will now occur through the creative destruction process of Table 4. This is also the endogenous growth mechanism of the Swedish micro to macro (MM) model, that I will return to below.

Standard econometrics, whether neoclassical WAD or neo-Schumpeterian, has been satisfied with modeling innovation as a technological output from an R&D fueled innovation function under item 2 in the competence bloc of Table 1. If this innovation or technology supply function (with or without an added stochastic element) is fed into a traditional production function, growth of output will automatically occur. This is more or less the same in the neoclassical and the open ended linear neo-Schumpeterian models. The profit optimization of the neoclassical growth models takes more price and cost variables into account, but imposes prior unrealistic specifications on the models that distort the econometric results. When decision making is thought of as a costly exploration of the vast and expanding state space of an EOE, commercialization draws large resources and learning that expands state space occurs in response to non-stochastic business mistakes, these models won't do.

Ballot *et al.*[31] have simulated such an improved commercialization process (notably industrially competent venture capital financing) on a model version of the Experimentally Organized Economy, the Swedish MM model[32] which features economic learning and growth through a Schumpeterian creative destruction process of the kind presented in Table 4. The improvement in learning feedback achieved, as expected, generated a long term increase in economic growth.

On the Hazards of Using Linear Decision Models in a Non-linear Economy

Strategic decision making based on analytical methods ('analytical strategizing') is commonly taught at business schools. Analytical methods have to be based on prior assumptions similar to those that enter statistical learning, namely the existence of an exogenous equilibrium that feeds back statistical information to be analyzed that is not affected by the learning and decision process itself. Historical data then are assumed to include all information you need to map out the future. Such decisions methods are, however, highly failure prone in an experimentally organized market economy (EOE) in which the analytic management process of a firm by definition is incomplete and unreliable. As the economic structure ('quantities') change because of the decisions taken and learning, prices become increasingly unreliable as predictors of future prices and structures and the incidence of business failure increases. I have studied historically[33] how business information and planning systems structured on the early post-WWII steady state and predictable growth experience failed miserably when used in the new and radically changed oil crisis economic environment of the 1970s. We have simulated the same outcomes on the Swedish MM model and found that firms using analytical decision models failed increasingly under a regime with increasingly unreliable learning feedback under item 6 in Table 2.[34] The reason for this unreliable feedback was that the too rapid structural change was reflected in the form of disorderly price responses. In popular language the economy was out of equilibrium. In more precise language you cannot, however, say so because there exists no well defined exogenous equilibrium to 'be out of' in the Swedish MM model (see further below). In the end the

performance of the entire macro economy began to decline.[35] Under such circumstances it becomes more important for top management to be attentive to the identification and correction of non-random business mistakes that are constantly committed (items 3 and 4 in Table 2) than to attempt to do it right from the beginning. The reader should note here that situations as those just described are ruled out by assumption from the WAD model. In the EOE they, however, occur all the time. A top management that is neither curious nor attentive to unpredictable market change is therefore a common attribute of failing firms in such an experimental setting.

Static equilibrium has found a reasonable home in financial economics where transactions and responses to exogenous changes in information (in the Ω above) are for all practical purposes immediate, meaning, however, as well that a new equilibrium is immediately restored. In fact, both financial economic theory and practice rest on optimal pricing algorithms for financial instruments such as options derived from models in static equilibrium.[36] When the financial system, and for that matter the entire economy, is not in static equilibrium such optimal pricing algorithms no longer hold, and financial markets may easily be pushed out of such an equilibrium if the rest of the economy is perturbed. If financial agents continue to trade in financial instruments according to those price setting algorithms, financial disaster is invited and for considerable time without being recognized, as the current 2008/09 global economic crisis illustrates. The reason this can happen is that traders in financial markets are not familiar with the limitations of their trading tools. It is intellectually difficult stuff to understand both the mathematics of the instrument and how it relates to the business situation. To understand what is going on you have to place your simplified computing tool developed for a WAD economy in the broader context of a dynamic economy-wide model of the EOE type to study what kind of mistakes you may commit. Broström[37] has done exactly that on (again) the Swedish MM model that has a financial system that is integrated through the internal economies of firms and financial institutions with the rest of the economy. Broström equips the financial traders (inter alia) with capital asset pricing models (CAPM) to support their decisions. He finds that the predictive reliability of the beta is very low in a macro economic environment (that of the MM model) when the economy is not in the neighborhood of the kind of equilibrium assumed for the CAPM model.

One could say that the above examples illustrate the risks of using *linear decision models in a non-linear experimentally organized economic environment*. The Swedish MM model features highly non-linear structural dynamics and correspondingly highly unreliable price signals.[38] Single valued 'equilibrium' decision models are needed to arrive at one decision. Hence, linear decision models are used in that model by firms to interpret price and quantity signals to be able to come up with single valued decisions. Thus business mistakes will be constantly committed. Such mistakes change the structure of the economy that the decision makers need to know about and approximate with linear forecasting and decision models. Hence, learning feedback in Table 2 (item 6) becomes increasingly unreliable.

Antonov and Trofimov[39] took that possibility as a starting point for a central planning experiment on the Swedish MM model. The central planning authority instituted in the model enforced the use of one single forecasting and decision model by all firms. Two types of firm decision models were tried; one linear Keynesian and one linear neoclassical. None of them captured the highly non-linear and shifty environmental structure facing the individual firms in the micro to macro

model. The long term macro economic development simulated still did not differ much under the two enforced forecasting/planning regimes.

In a third experiment firms were allowed to make their own individual decisions using whatever ad hoc correlations they came upon. This experiment produced the best long term growth trajectory since the now unconstrained individual actors were free to discover and commercialize winning investment projects that they never came upon in the constrained planning alternative.

The Equilibrium Revisited

The above experiments on the Swedish MM model illustrate the perhaps most serious limitation of the WAD model. The priors that have gone into the specifications of the model to ensure the existence of an exogenous equilibrium have reduced the operating domain of the model to that of a centrally planned economy. There will never by prior assumption be better theoretical allocations of resources than those achieved by the Walrasian (WAD) auctioneer, the Soviet central planner or the central policy maker. The mainstream WAD model prevents the theorist from seeing better allocations beyond those priors, for instance those only achievable within a dynamic capitalist market economy, or for that matter, an EOE. This observation was first made by Demsetz'[40] 'Nirvana fallacy' and further developed by Pelikan.[41] The interpretation of any econometrically estimated derived or partial form of the WAD model should therefore include a careful evaluation of the biases that come with those priors. One frequent consequence of not performing this test of relevance has been the intellectual ease with which economists use their econometric results to suggest additional government action, when another, more general model might have come up with the result (read policy conclusion) that we really don't know so reduce the policy action. The implication might even be the same as that often attributed to management consultants, that equilibrium policy models have been developed to please the policy makers by making them believe that they can do more good than they really can. So also here we meet with policy 'misinformation systems' of the kind discussed by Ackoff.[42]

The conclusion comes naturally *that whatever reduced form or partial model is being econometrically studied, it should be carefully interpreted and understood in the context of the wider dynamic model or theory from which it has been derived to assess the risks of information biases.* I would say that this is the most important rationale for large scale dynamic economic modeling; to understand, not to compute or forecast.

The mainstream WAD model economy with a fixed point or steady state predictable equilibrium carries the risk of serious misspecification and information biases. There is a large literature on the life in, or on that equilibrium, and very little on what happens if the economy departs from the same equilibrium, beyond a random slight deviation. The model version of the theory of the EOE, the Swedish MM model features no such exogenous equilibrium, at least as far as we know, and it is capable of explaining what happens 'out of equilibrium'. The ultimate direction in which the model chooses to head depends on its initial state and the empirical characteristics of the decision process of all firms as intermediated through markets. The MM model is therefore very demanding on high quality statistical measurement. The diversity of the state space or investment opportunities space of the model economy is sufficiently great to make the ultimate outcome for all practical purposes unpredictable. So the honest economic analyst cannot but be aware of the limitations of his/her 'tool of analysis'.

There is more to say on this. The MM model can also be manipulated through the simulation of increasingly rapid market responses to move it as close as is possible to a steady state type equilibrium. This equilibrium towards which the model economy can be pushed may be defined in terms of the distribution of individual differences in the returns to equity over the individual firm interest rates. Capital market equilibrium is said to have been reached when that distribution becomes flat.[43] The outcome of those simulation experiments carries significant interest for the analyst/policy maker. The closer the economy is pushed to a flat distribution the stronger market reactions in the model push the economy away from it. The faster the market speeds imposed, the stronger the markets counter react. Eventually the entire model economy is violently destabilized and collapses, a result that is indicative of the non-existence of an external equilibrium of the conventional type. Endogenous loss of firms (exit) through intensified competition, and rapidly disappearing diversity of structures were the reason for the collapse. Expressed in different terms, the highly non-linear Swedish MM model economy had gone through a chaotic phase that was sufficiently dramatic to make the entire economy collapse. The later Eliasson *et al.* experiments on the same model, however, demonstrated that the collapse in the earlier experiments could have been prevented by upholding the diversity of structures in the model economy through a more vigorous endogenous entry and exit of innovative firms;[44] but there was an end to that possibility as well. Eventually, as firm turnover and market speeds were increased macro economic long term growth performance of the economy began to deteriorate. There was an intermediate rate of change compatible with 'optimum' long term growth.

Such performance deterioration is reflected either in a rapid and very slowly adjusting micro environment, or in an increasingly unstable and unpredictable micro environment in the model economy, the 'optimum', if you can use that term, being somewhere in between. This suggests that the stability of the micro environments of the model, a typical welfare related concept,[45] is more interesting than the imaginary exogenous equilibrium fix point or steady state that may not even exist as an operating domain of a realistically specified model economy. Here is a relevant theme for the ambitious economic theorist to pursue further, and for the realistic policy maker to be interested in.

If the economist nevertheless insists on doing equilibrium analysis of the mainstream type you should define a new and more expanded equilibrium definition, namely a multidimensional region within which you want the economy to operate that is compatible with: (1) reasonably stable and acceptable long term macroeconomic growth; and (2) socially acceptable unpredictable instability of micro environments.[46] This can be done through determining, through repeated simulation experiments, the range of parameter settings in the model that is compatible with the above criteria. The latter world opens up a vast agenda of possible policy inquiries into labor market, educational and social policy making to make individuals able to cope and happy to accept a more disorderly, but at the same time more entrepreneurial and economically prosperous economy, for instance the differences between the European and US economic, cultural and political systems.[47]

While a disorderly micro environment may be politically prevented from developing at the cost of lost future growth in output, if accepted to the benefit of society the consequences for business agents are interesting. While policies tend to protect people from being subjected to extreme exposure to the vagaries of markets, the morale of the markets that applies to the business community is

different. Clever business agents can thrive in, and profit from, both stagnating and growing economies and the life of an inferior business firm is not worth much. Competition policy is in fact designed to raise productivity and growth through an increased rate of elimination of inferior producers, not to protect them.

The Business Case

The single most important postulate in economics is what is assumed about the state space or business opportunities space of the model. I have shown with reference to simulation experiments on the Swedish MM model, being an approximation of the EOE, that even a model approximation of an EOE may exhibit sufficient complexity and diversity to make long term micro and macro outcomes utterly unpredictable, and force individual actors (firms) in the model to use simple 'linear' decision models to be able to come up with single valued decisions. The complexity of the Swedish MM model is, however, only a vague foreshadow of what reality has to offer.

Business success has often been argued in the analytical community to be linked to the reliability of business information systems and the rationality of their decision processes, but if not well designed for the business environments we may come up with management systems that misinform rather than improve upon decisions.[48] Above all this is the case if the a priori imposed logical consistency of the information system closes management eyes to negative consequences that lie outside the awareness of the information system, or to opportunities that would have been discovered, had management not been preoccupied with the business story contained within their strategic information system.

The Swedish Ericsson planned venture into the business information systems market in the early 1980s and its parallel and completely unplanned capture of the global market for mobile telephone systems illustrate the theoretical arguments just concluded for the business man. The business information systems venture was about the development of a rationally conceived centralized information instrument for a predictable WAD type economy built around the idea of a 'universal information' system.[49] It was supposed to include access to internal and external databases that would be capable of supporting informed decisions in all possible situations on an analytical format. Information was what was believed to be important, not access to people with tacit and non-communicable knowledge. The concept was perfectly logical for a WAD type economy construed on a forecasting and central planning mode; and Ericsson was not alone in pushing into this market with such a product. It did so in the early 1980s together with close to 50 other large and established companies, most of them in the computer and telecom markets. They all failed to the tune of billions of dollars.[50]

The reason was partly that the information product had been derived from an idea of what technology at the time would be capable of achieving, *not from an understanding of what decision makers needed.* The technology of the time, the early 1980s, however, was not by far ready for such information products requiring enormous data storage and communication capacities. The main reason for the failure, however, was that the product itself was not what top decision makers in firms needed or wanted, and in addition that *the task of constructing a universal information system capable of handling all expected and unexpected decision situations was theoretically impossible to begin with*, at least in what I have called an Experimentally Organized Economy (EOE).

The notion of access to people with knowledge and information not expected to be needed and on a format not prepared for had not been part of the universal information systems design. This turned out to be what decision makers needed when the first round of oil crises struck during the 1970s.[51]

Ericsson abandoned the information systems venture altogether in the late 1980s, but this preoccupation of Ericsson top management for many years almost killed the golden opportunity in mobile telephony that was emerging at the same time. No analytic strategic design had been capable of conceiving that possibility. It had to be discovered as it emerged, and preoccupied minds have difficulties discovering odd 'outside' opportunities.

The story of Ericsson's successful but completely unplanned entry into the mobile telephone market is therefore entirely different from the information systems failure. The opportunity was not understood on the basis of careful business strategic analysis and planning. The emerging business opportunities in mobile telephony at the time were not 'embodied' in any strategic business information system or, for that matter, in anybody's previous experience.

This time *a sophisticate customer*, the curious and competent Swedish public telecom authority (Televerket, item 1 in the competence bloc Table 1) with plenty of money was pushing a reluctant Ericsson management to enter the mobile telecom market. Ericsson top management was, however, entirely absorbed by its parallel venture into the information systems market and was not interested for a long time. It took a crisis and management change to make it react.

Fortunately for Ericsson its top management had been unable to stop an in-house skunk work in its military radio subsidiary Svenska Radio AB (SRA, later Ericsson Radio Systems) and its stubborn manager, who resisted top management pressure to terminate development work on radio telephony using a secret slush account provided from a military budget. Ericsson, and possibly also Nokia, were alone among all telecom and computing firms to have an in-house radio activity. Thanks to that, Ericsson as a company was technologically prepared when its top management finally realized they had a winner in the house. Money now was no problem (items 4 and 5 in Table 1) and industrial competence (item 6) to scale up was to some extent already available internally.

Mobile telecom systems turned out to be an increasingly complex and difficult challenge for the telephone companies. In the beginning, however, the volume manufacturing of cell phone terminals was considered to be the great opportunity. The Ericsson marketing people, however, being more accustomed to dealing with a few government customers than with many fickle, fashion conscious and unpredictable individuals, turned out not to be experienced players in the consumer electronics markets. Ericsson therefore merged its hand terminal business with Sony's into a separate company, *Sony Ericsson*, in 2001, which, even though currently (2009) in trouble, has very recently been the third or fourth largest player in the world.[52] Ericsson focused on the mobile telephone systems market and found, to a large extent thanks to its military radio, antennae and micro wave communications technologies, that its competitive advantage was in the systems market. Ericsson has so far made the right technological choices and is today the dominant player in the global mobile telephone systems market, up from a 100% dependence on fixed line land based switches in 1980 to a 100% base in mobile telephony systems today. But the market is highly competitive and unpredictable, and the Chinese, not the Americans and the Europeans, are increasingly challenging Ericsson's leadership position.[53]

Notes and References

1. This paper collects and integrates a number of ideas that I have entertained in a number of partial contexts that I will refer to as I go along. There may be too much content compacted into a few pages, but the beginning of my story needs to be connected to the end.
2. Gunnar Eliasson, *Business Economic Planning–Theory, Practice and Comparison*, John Wiley & Sons, London, 1976, p. 260.
3. R. L. Ackoff, 'Management misinformation systems', *Management Science*, 14, 4, December 1967.
4. D. M. Lamberton (ed.), *Economics of Information and Knowledge. Selected Readings*, Penguin Books, Harmondsworth, 1971, p. 9.
5. D. M. Lamberton, 'The information revolution', *The Annals of the American Academy of Political and Social Science*, 412, March 1974, p. ix (Introduction).
6. F. Knight, *Risk, Uncertainty and Profit*, Houghton-Mifflin, Boston, MA, 1921.
7. To avoid unnecessary critical comments I add already here that this is a stylized way of presenting the mainstream WAD model. There have been many attempts to overcome the restrictive assumptions just mentioned and some of them make a lot of sense in the context of econometric measurement. My analysis is, however, concerned with *understanding dynamics* and for that you have to get out of the intellectual straight jacket of the exogenous equilibrium notion of economics.
8. See Dale W. Jorgenson, 'Econometric methods for modeling producer behavior', in Z. Griliches and M. D. Intriligator (eds), *Handbook of Econometrics*, North Holland, Amsterdam, 1986, pp. 1841–915; D. W. Jorgenson and Z. Griliches, 'The explanation of productivity change', *Review of Economic Studies*, XXXIV, 3, July 1967, pp. 249–82; and D. W. Jorgenson, J. Steven Landefeld and William D. Nordhaus, *A New Architecture for the US: National Accounts*, The University of Chicago Press, NBER Studies in Income and Wealth, Chicago, IL and London, 2006, Vol. 66.
9. See for instance L. E. Blume, M. M. Bray and D. Easley, 'Introduction to the stability of rational expectations equilibrium', *Journal of Economic Theory*, 26, April 1982, pp. 313–7; M. N. Bray, 'Learning, estimation, and the stability of rational expectations', *Journal of Economic Theory*, 26, 1982, pp. 318–39; and R. Frydman, 'Towards an understanding of market processes: individual expectations, learning, and convergence to rational expectations equilibrium', *American Economic Review*, 72, 4, September 1982, pp. 652–68.
10. Gunnar Eliasson, 'Business competence, organizational learning and economic growth-establishing the Smith–Schumpeter–Wicksell connection', in F. M. Scherer and M. Perlman (eds), *Entrepreneurship, Technological Innovation, and Economic Growth: Studies in the Schumpeterian Tradition*, University of Michigan Press, Ann Arbor, 1992.
11. Most analyses in financial economics assume stationarity. There are, however, attempts to break through this restrictive assumption (see K. F. Wallis, 'Econometric implications of the rational expectations hypothesis', *Econometrica*, 48, 1, January 1980, pp. 49–73). To avoid a 'technical misunderstanding', please note that both assumptions 3 and 4 are stochastic equilibrium conditions. During a learning phase, non-stationarity is possible. To avoid having learning itself affect the stationary equilibrium, learning costs have been assumed to be zero. See, however, C. Fourgeaud, C. Gourieroux and J. Pradel, 'Learning procedure and convergence to rationality', *Econometrica*, 54, 4, July 1986, pp. 845–68 who attempted to make their equilibrium dependent on the learning process.
12. T. Haavelmo, 'The probability approach in econometrics', *Econometrica*, 12, July 1944, Supplement.
13. E. F. Fama, L. Fisher, M. C. Jensen and R. Roll, 'The adjustment of stock prices to new information', *International Economic Review*, 10, February 1969, pp. 1–21.
14. Knight, *op. cit.*
15. Tord Palander, 'Om "Stockholmsskolans" begrepp och metoder. Metodologiska reflexioner kring Myrdals "Monetary Equilibrium"', *Ekonomisk Tidskrift*, XLIII, 1, March 1941, pp. 88–143.
16. Knut Wicksell, *Geldzins und Güterpreise*, 1898. (English translation: *Interest and Prices*, published by Macmillan, London, 1965.)

17. F. Modigliani and K. Cohen, *The Role of Anticipation and Plans in Economic Behavior*, University of Illinois Press, Urbana, IL, 1963. Also see Gunnar Eliasson, *Kreditmarknaden och Industrins Investeringar- en ekonometrisk studie av företagens kortsiktiga investeringsbeteende*, Almquist & Wicksell and Industriens Utredningsinstitut (IUI), Uppsala, 1967; and Gunnar Eliasson, *The Credit Market, Investment, Planning and Monetary Policy-An Econometric Study of Manufacturing Industries*, IUI, Stockholm, 1969.
18. See Gunnar Eliasson and Åsa Eliasson, 'The theory of the firm and the markets for strategic acquisitions', in U. Cantner, E. Dinopoulos and R. F. Lanzilotti (eds), *Entrepreneurship. The New Economy and Public Policy*, Springer, Berlin, Heidelberg, New York, 2005; and Gunnar Eliasson and Åsa Eliasson, 'Competence and learning in the experimentally organized economy', in P-O. Bjuggren and D. C. Mueller (eds), *The Modern Firm, Corporate Governance, and Investment*, Edward Elgar, Cheltenham, UK and Northampton, MA, 2009.
19. Carl-Johan Dahlman, 'The problem of externality', *Journal of Law & Economics*, 2, 1979, pp. 141–62.
20. Knight, *op. cit.*
21. This is the definition of an efficient market, see E. F. Fama, 'Efficient capital markets. A review of theory and Empirical work', *Journal of Finance, Papers and Proceedings*, 25, May, 1970, pp. 383–417; and E. F. Fama, *Foundations of Finance,* Basic Books, New York, 1976. If all that can be known (denoted Ω) changes (to a new Ω^*) the assumption is that the efficient market immediately establishes a new equilibrium where agents know everything that can now be known (or Ω^*). The critical question is to clarify what is meant by 'all that can be known', a question that only makes sense in the EOE, and how agent learning may influence the Ω.
22. T. Lindh, 'Lessons from learning about rational expectations', in Richard H. Day, Gunnar Eliasson and Clas Wihlborg (eds), *The Markets for Innovation, Ownership and Control*, IUI, Stockholm and North-Holland, Amsterdam, 1993.
23. From the pig Särimner in the Viking sagas that was eaten by the Vikings for supper, only to return again the next day to be eaten again, and so on. The difference in the economics of the EOE is that the pig grows from being eaten. See Gunnar Eliasson, *Firm Objectives, Controls and Organization-The Use of Information and the Transfer of Knowledge within the Firm*, Kluwer Academic Publishers, Boston/Dordrecht/London, 1996, pp.27 ff; and Gunnar Eliasson, 'The nature of economic change and management in a new knowledge based information economy', *Information Economics and Policy*, 17, 2005a, pp. 428–56.
24. As Bray clarifies, a number of additional tough assumptions have to be satisfied for this to hold, but this added difficulty of learning only reinforces my argument (see Bray, *op. cit.*).
25. See Herbert A. Simon, 'A behavioral model of rational choice', *Quarterly Journal of Economics*, 69, 1955, pp. 99–118.
26. For a proof that heterogeneity in bounded knowledge or knowledge is sufficient to establish the existence of tacit knowledge in the sense of limited communicability, see Gunnar Eliasson, 'The firm as a competent team', *Journal of Economic Behavior and Organization*, 13, 3, June 1990, pp. 276 f.
27. See Eliasson, 1996, *op. cit.*, Section III.1.
28. Also see Eliasson, 1996, 2005a, *op. cit.*
29. The commercialization process in fact draws much larger resources than the innovation process.
30. See p. 73 in Gunnar Eliasson (ed.), *The Birth, the Life and the Death of Firms—The Role of Entrepreneurship, Creative Destruction and Conservative Institutions in a Growing and Experimentally Organized Economy*, The Ratio Institute, Stockholm, 2005b.
31. See Gerhard Ballot, Gunnar Eliasson and Erol Taymaz, 'The role of commercialization competence in endogenous economic growth', paper presented to the *International J.A. Schumpeter Society 11th ISS Conference*, Nice-Sophia Antipolis, 21–24 June 2006.
32. See Gunnar Eliasson, 'Competition and market processes in a simulation model of the Swedish economy', *American Economic Review*, 67, 1, 1977, pp. 277–81; Gunnar Eliasson, 'Modeling the experimentally organized economy—complex dynamics in an empirical micro–macro model of endogenous economic growth', *Journal of Economic Behavior and*

Organization, 16, 1–2, 1991, pp. 153–82; and Gerard Ballot and Erol Taymaz, 'Human capital, technological lock-in and evolutionary dynamics', in G. Eliasson and Ch. Green, *The Micro Foundation of Economic Growth*, University of Michigan Press, 1998, pp. 301–30.

33. See Eliasson, 2005a, *op. cit.*
34. Gunnar Eliasson, Dan Johansson and Erol Taymaz, 'Firm turnover and the rate of macroeconomic growth', chapter VI in Gunnar Eliasson (ed), 2005a, op. cit.
35. Technically the increasingly disorderly environment of the EOE represented by the Swedish MM model was engineered by raising entrepreneurial competitive entry of the economy from none, via normal to increasingly reckless. When the birth and death rates of firms (firm turnover) passed beyond a certain level the long run macro performance of the model economy began to deteriorate.
36. See F. Black and M. Scholes, 'The pricing of options and corporate liabilities', *Journal of Political Economy*, 81, 1973, pp. 637–59; and R. C. Merton, 'An intertemporal capital asset pricing model', *Econometrica*, 41, 1973, pp. 867–87. Also see Gunnar Eliasson, 'Industrial policy, competence blocs and the role of science in economic development', *Journal of Evolutionary Economics*, 10, 1–2, 2000.
37. See Anders Broström, *The Reliability of the CAPM under Different Macro Economic Environments*, Masters Thesis at The Linköping Institute of Technology & The Royal Institute of Technology (KTH), The Department of Production Economics, LiTH IPE Exarb, 2003, p. 672.
38. And part of that dynamics in the MM model economy has to do with the macro economic feedback of agents using linear decision models that all more or less misrepresent the decisions situation of the individual agents.
39. See Michail Antonov and Georgi Trofimov, 'Learning through short-run macroeconomic forecasts in a micro-to-macro model', *Journal of Economic Behavior and Organization*, 21, 2, June 1993.
40. See Harold Demsetz, 'Information and efficiency: another viewpoint', *Journal of Law and Economics*, 12, April 1969, pp. 1–22.
41. See Pavel Pelikan, 'Why private enterprise? Towards a dynamic analysis of economic institutions and policies', in *IUI Yearbook 1986–1987*, IUI, Stockholm, 1986; and Pavel Pelikan, 'Can the imperfect innovation systems of capitalism be outperformed?', in Giovanni Dosi, Richard Nelson, Gerhard Silverberg, Luc Suete and Sidney Winter (eds), *Technical Change and Economic Theory*, Pintner Publishers Ltd, London, 1988.
42. Ackoff, *op. cit.*
43. See Gunnar Eliasson, 'Micro heterogeneity of firms and stability of growth', *Journal of Behavior and Economic Organization*, 5, 3–4, September–December 1984, pp. 249–98; and Eliasson, 1991, *op. cit.*
44. Eliasson *et al.*, *op. cit.*
45. See Gunnar Eliasson, 'On the optimal rate of structural adjustment', in G. Eliasson, M. Sharefkin and B.-C. Ysander (eds), *Policy Making in a Disorderly World Economy*, Conference Reports, IUI, Stockholm, 1983, p. 1; and Eliasson, 1984, *op. cit.*
46. See Eliasson, 1983, *op. cit.*
47. See Gunnar Eliasson, 'From employment to entrepreneurship', *Journal of Industrial Relations*, 48, 5, 2006a, pp. 633–56; and Gunnar Eliasson, 'Policies for a new entrepreneurial economy', paper presented to the *International J.A. Schumpeter Society 11th ISS Conference*, Nice-Sophia Antipolis, 21–24 June 2006b, to be published in the *Journal of Evolutionary Economics*.
48. Ackoff, *op. cit.*; Eliasson, 1976, *op. cit.*
49. For an in-depth discussion on the notion of a universal information system see Eliasson, 1996, *op. cit.*
50. This story has been told in detail in Eliasson, 1996, *op. cit.*, chs V and VI and Supplement I.
51. See Eliasson, 2005a, *op. cit.*
52. *Dagens Industri*, 21 February 2001, p. 18f; SvD, 22 October 2008.
53. *The Economist*, 26 September 2009, p. 10f.