1990–08–24
1990–12–31

A list of Working Papers on the last pages

No. 264, 1990

BUSINESS COMPETENCE, ORGANIZATIONAL LEARNING AND ECONOMIC GROWTH – Establishing the Smith–Schumpeter–Wicksell (SSW) Connection

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To be published in *Entrepreneurship, Technological Innovation, and Economic Growth: Studies in the Schumpeterian Tradition.* F. M. Scherer and Mark Perlman (Eds.). University of Michigan Press. 1992.

September, 1990
Revised January 1991

GE/mini/Schum/Perl/jan91) 1990–12–31

BUSINESS COMPETENCE, ORGANIZATIONAL LEARNING AND ECONOMIC GROWTH

– establishing the Smith–Schumpeter–Wicksell (SSW) connection

by Gunnar Eliasson, IUI

> "Likewise we found a remarkable difference in the organization of work at our shipyards compared to those in other countries. Here, almost two days of work were needed to accomplish what took only one day in England or Holland. ....On this and other things I want to say that.... Swedish hands when appropriately directed and put to use, lack neither skill nor force".
>
> Johan Westerman, "**Om svenske näringarnes undervigt gentemot de utländske, förmedelst en trögare arbetsdrift**" (On the inferiority of Swedish compared to foreign manufacturers because of a slower work organization (my translation)) Stockholm, Lars Salvius publisher, 1768 (pp. 7f).

Abstract

The firm is defined in terms of its financial objectives, achieved through human-based organizational competence, conferring scale economies on all other factors. Competence is developed through organizational learning, jointly produced with the value added of the firm, largely manifesting itself in organizational change. Such learning draws considerable resources, partly through mistakes and is subjected to strongly

diminishing returns.

Learning occurs in an enormous and heterogeneous state space (the business opportunity set) that expands in pace with innovations. The economy, hence, is always far from a state of full information. Experimental search into state space to achieve financial objectives (incentives) drives technological competition, being conditioned by higher probability of failure if learning is not efficient, compared to learning in competing firms. The more rich and varied the economic environment (state space) the larger the potential for learning and innovation, but also the more intense potential competition. Competition steadily depreciates the economic value of acquired knowledge of all other competitors, increases productivity and drives the macro economy. The realization of plans in the markets selects winners and sorts out losers. With the creating, the use, and the diffusion of knowledge subjected to technical change this realization process is typically non-stationary and non-learnable by analytical methods. It defines the experimental nature of the organization of dynamic markets (Eliasson 1987, 1988a, 1990b). The superior competence acquired through organizational learning moves total factor productivity growth.

1. The Intellectual Dimension of Economic Activity[1]

The cornerstone of western intellectual thought is the search for a true state of affairs, assumed to exist. This idea runs through science and art. This idea of something ultimate that is invariant to our endeavors to uncover it, is a comforting idea. We need it as human beings to feel at ease in a seemingly disorderly world. The notion of an equilibrium, preferably a situation of perfect information, hence, bounds our mind to reject on prior grounds evidence against it. Business leaders need this intellectual comfort to dare take the bold decisions required of them. You and I need it to feel at ease. The economist needs it to be able to advice politicians. Healthy minds do not ask too deep questions to make them skeptical about their prior assumptions. In fact, the important part of business competence is to organize "the mind of the firm", so that decisions can be taken.

In the old days, with primitive observational techniques in social sciences, the mind of economists could wander rather freely along strange roads. Even though economic knowledge could not be measured, nor its existence proven, it was an obvious fact that knowledge, and hence learning mattered. Early texts in economics were very open to this unobservable entity. John Stuart Mill (1848) made knowledge a critical factor in economics. The Swedish economist Westerman (1768) who traveled to England to learn about "the new machines" was very clear in his assessment. What mattered was not the machines, but the human competence to organize machines and men, to know what products to produce and how to make customers happy with them.[2] The absence of data, however, allowed the social scientist to speculate rather freely about the nature of economic competence.

This situation changed with the improvement of economic measurement techniques, beginning with the development of consistent cost accounting systems for firms, continuing with the establishment of elaborate national accounts systems. The mind of the economist was now forced to conform to measurement. Economics became a "hardware science", and knowledge was forgotten for more than a century (Stigler 1961, Eliasson 1989a). The problem is that the intellectual dimension of economic activity is still there. The intellectual veil of the economy is not neutral. It imposes its mind on the hardware performance of the real economy and it draws considerable resources (Eliasson 1990a,b). So it is outright wrong to neglect it.

General equilibrium has to include capital market equilibrium, meaning a situation where rates of return of all agents equal the interest rate. Since a rate of return independent of the stock of capital cannot be defined – except as a statistical artifact – this is a non-existing situation ex post.[3] Both ex ante and ex post individual firm rates of return differ from the market interest rate by a measure that I will call $\bar{\varepsilon}_j$ (for the firm j). There is a distribution of $\bar{\varepsilon}$ that separates the rates of return from the market interest rate (see Figure I.A). Before modern general equilibrium-based finance theory reinterpreted these epsila as a (stochastic) distribution of insurable risks around the exogenous equilibrium interest rate, McKenzie (1959) observed that (perhaps) these deviations could be interpreted as returns (negative or positive) to firm specific assets, or as competence that did not appear explicitly in the accounts of the firm. In Eliasson (1985a, Ch. VI) I have followed up on this and made $\bar{\varepsilon}$ corrected for inflation the underpinning of total factor productivity growth, or the shift factor in the production function. I will return to the mathematics of this derivation at the end of the paper.

I make the firm, existing on a unique or specific knowledge asset ["top level organizational competence"; Eliasson 1990b], the main agent behind economic growth. The firm is defined by its financial objectives and its capacity to steadily upgrade its competence through organizational learning. The competence endowment of the firm confers economies of scale to all other factors of production. Organizational learning draws considerable resources, not in the least in the form of mistakes, causing learning to be subjected to rapidly diminishing returns. Organizational learning includes the capacity to create new competence internally (innovation) and of acquiring knowledge in external markets. It also includes methods of efficiently diffusing new knowledge through the organization, while keeping the knowledge within the organization. Apparently the acquisition of knowledge in external markets requires receiver competence, a competence that also has to be learned. Since competence is human, or team embodied it is to some extent tradable in the labor or in the stock markets (Eliasson 1990b,c).

While Romer (1986) saw knowledge as an externality that conferred economies of scale to all other factors of production, I reinterpret that idea (in Eliasson 1989a, 1990b) in terms of a general organizational knowledge, learned or acquired by the firm as it carries out production and participates in market competition. The accumulated knowledge earns a rent ($\bar{\varepsilon}$) that is the rationale for the existence of the firm. In order to be, however, this knowledge has to be embodied in the organization. If it diffuses too easily, so does the rent and, hence, the firm itself. It has to have the character of property, i.e. either to be protected (ownership, patent, copyright) or be proprietary through "tacitness". Since competence is, to a large extent, tacit and acquired through experimental learning, it has no well defined reproduction value. The difficulties associated with measuring tacit organizational knowledge directly illustrate this and establish the imperfect nature of markets that trade in such assets.

Entrepreneurial competence is defined by Schumpeter (1912) as the competence to create new combinations that enter the capital market as temporary monopolies ("firms"). This is the function assigned to the entrepreneur by Schumpeter. The other side of this competence is to spot market imperfections and exploit them. This is the innovative trader of Kirzner (1973). Entrepreneurial activity, hence, manifests itself as competition based on the competence to create new organizational knowledge (innovation), thereby reducing the economic value of existing structures of knowledge. The term that I use is <u>organizational learning</u>, on which the firm bases its <u>rent</u> ($\bar{\varepsilon}$) and, hence, its existence. Competence capital acquired by organizational learning is defined by its rent ($\bar{\varepsilon}$). Organizational learning is the essence of the dynamic competition that drives economic growth of Smith (1776), Clark (1887) and Schumpeter (1912). It explains the divergence between the ex ante rate of return and the interest rate, and can be interpreted as the force behind the disequilibrium, cumulative process of Wicksell (1898).[4] I call this alternative to the classical Walras–Arrow–Debreu (WAD) model, the Smith–Schumpeter–Wicksell (SSW) model. It is fairly straightforward to demonstrate that the ex ante difference ($\bar{\varepsilon}$) of the SSW economy, based on a belief in a superior competitive situation on the part of the individual, the entrepreneur or the firm is a powerful economic force that shapes future industrial structures.

This disequilibrium variable $\bar{\varepsilon}$ can even be measured. To measure the capital that generates the rent – the content of the knowledge – is, however, impossible, since it embodies the capacity to generate new, previously unknown knowledge. There is, nevertheless, a way to observe the nature of $\bar{\varepsilon}$. You need knowledge to organize knowledge creation or acquisition. Hence, one can study how organizational learning is being organized in firms or acquired in external markets. This has been done in a separate paper (Eliasson 1990c).

This long introduction was needed to orient the rest of the paper. I have introduced the firm, the supply agent as based on tacit organizational knowledge, that is constantly updated and accumulated, using up resources, including the costs of failure. This accumulation process, that is fundamental for economic growth, I have called organizational learning. Section 2 introduces the experimentally organized economy (Eliasson 1987, 1988a) by changing a few assumptions in the classical model. Section 3 presents the firm as an organizational learner in that environment. It is established that learning costs are large, being partly incurred through failing business experiments, implying that at each point in time organizational learning is subjected to strongly diminishing returns. It is also demonstrated how a few modifications of the static, classical model, e.g. entry and exit, and a Salter type state representation of the economy are sufficient to create path-dependence and non-stationary behavior and to restrict the organizational learning capacity of the individual firm (bounded rationality). Section 4, finally, demonstrates that returns to tacit firm competence ($\bar{\varepsilon}$) relate directly to measured total factor productivity growth.

2. Experimental Organizational Learning as the Source of Economic Growth

Agents compete by learning to be better. The technology of learning determines agents' competence to figure out what all other agents will do and how markets work. While standard learning literature restricts this competence or knowledge to the choice of optimal forecasting methods to decode the signals emitted by the economic system, the economy I am studying requires a definition of learning that goes beyond the interpretation (by statistical estimation) of codable and tradable information. The accumulation of tacit, human-embodied knowledge makes it necessary to distinguish between the creation and the diffusion of knowledge, i.e. between innovation and learning, each of which possess particular efficiency characteristics, and each of which is discussed in different sets of literature.

Once we distinguish between the creation and the diffusion of knowledge the higher order of learning about the best way to create new economic knowledge (to innovate) enters. The competence to acquire efficient learning techniques is in turn subjected to learning, and so on. It is, as Pelikan (1989) argues, odd that economics has (for so long) assumed that the most important capital item behind the wealth of a nation, namely economic competence, has always been assumed to be abundant and that its allocation draws no resources. The accumulation and use of economic competence is a dynamic process concerned with the creation and diffusion of new knowledge, rather than with the allocation of existing knowledge. The economic value of existing knowledge is constantly destroyed by the creation and diffusion of new knowledge. This you can, however, learn to do better and better, a learning technology that you can in turn learn to improve upon. And so on. This is sufficient to preclude predictability at the micro decision level. It introduces trial and error as the normal mode of behavior.

From the classical model to the experimentally organized economy

As a decision maker in the market, however, you have to put a halt to this infinite regress in your search for higher orders of learning and awareness, to be capable of reaching a decision. To realize this "approximation", or choice of decision model competently, defines the competence of the firm. The social scientist or economist, on the other hand, is not allowed to do the same, because he then closes his eyes to an entirely new dimension of economic behavior, about which the economists of the Austrian and the Schumpeterian tradition were aware, a dimension that was washed away by the Walrasian–Arrow–Debreu (WAD) tradition.

My story is most clearly understood if I first relate it to the classical (WAD) model, as it appears on stochastic form in modern learning literature (Blume–Easley 1982, Bray 1982, Frydman 1982, Lindh 1989) or subsets thereof, such as rational expectations, or efficient market theory. The following assumptions define the classical model:

§ 1. Agents maximize expected utility – MAX(U)

§ 2. Expectations are formed from subjective probability distributions conditioned by "all available information" (= Ω), i.e. historic realizations of all stochastic variables – $EXP(X) = P(X|\Omega)$

§ 3. Agents form (through §§ 1 and 2) actual ex post probability distributions that are identical with the subjective probability distributions under § 2 – EX POST $P(X) \equiv P(X|\Omega)$

§ 4. EX POST P(X) are stationary.[5]

This is the classical model, formulated on a rational expectations mode, as it appears in modern finance (efficient market) and modern learning theory.

§ 4 is needed for economic ("econometric") learning, something made clear already by Haavelmo (1944). 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 P(X).

§ 3 hides the fundamental equilibrium conditions of the classical model that should be given up in any essay on Schumpeterian economics. In no way – tells § 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 identical to ex post, barring a randomly distributed difference term.

Ex ante and ex post distribution functions define the state space of the classical model. Changes in state space are occasioned by events (Fama et al. 1969), 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 learn the parameters of the new probability distribution $P(X|\Omega')$. Efficient markets immediately return the ex ante, ex post distributions to a stationary distribution. This leaves no room for the Schumpeterian innovator/entrepreneur who changes the parameters of the system, only for the Kirznerian trader/entrepreneur, who equilibrates the system after it has been perturbed. A couple of innocent assumptions, however, prevents you from reverting back to the classical model. The capacity to learn about the heterogeneous business opportunities by analytical methods depends on the size of state space. If made sufficiently large non-stationarity will eventually prevent classical or rational expectations type learning (Eliasson 1990b). The decision of the firm thereby dramatically changes. Each agent now has to evaluate, at each point in time, not only all future path choices it can make, but also how to react to the corresponding choices of all other agents. This requires learning capabilities of higher orders, and establishes experimental exploration into state space as the only viable learning method, and thereby path-dependence.

Now each actor realizes that he or she has to take on business risks that cannot be assessed on the basis of an historic flow of realized economic activity. "Regime shifts" prevent that. History cannot be assumed to have been generated by a "learnable" stationary process.[6] Hence, there will be no insurer willing to pick up the risk on the basis of past risk experience. Pure uncertainty prevails as distinct from computable risks (Knight 1921), and the firm, or the entrepreneur establishes itself in the market[7] by absorbing this uncertainty on the basis of his or her selfperceived ability to convert uncertainty into computable risks (Eliasson 1990b). [How the firm acquires the organizational competence to do this is the rest of my story, after I have made a few observations from the history of economic thought.]

The realization function, or the Stockholm School connection

You may believe that you understand the mechanisms that determine your economic environment, except for a random disturbance. You then face a lottery the expected value of which you can learn by playing repeated games. Computable risktaking is your business. Posit, however, that this assumption about stationarity is wrong. Suppose the parameters of the casino are changed now and then to prevent you from learning. The nature of your business risks should now be looked for in the transition from ex ante plans to ex post realizations, the realization function a notion that originated in the thinking of the Stockholm School economists (Wicksell, Myrdal, Lindahl, Svennilson, Lundberg etc. See Palander 1941 and also Eliasson 1967, 1969 and Modigliani–Cohen 1961). In dynamic markets innovative competitors change the parameters of the game constantly, and make the realization function a non-stationary process, thus violating assumptions §§ 3 and 4 (above) in the classical model. The business man now faces uncertainty and will rush around looking for transformations that allow him to compute and predict.[8] By making the unpredictable innovator/entrepreneur of Schumpeter (1912) the agent that changes the parameters of the economic system and the moving force behind the systematic discrepancies arising out of the realization process, I have established a nice connection between Wicksell and the Stockholm School economists on the one hand, Adam Smith and the Austrian School and the early Schumpeter, on the other – the SSW model. But this unpredictability originating in the path-dependence and non-stationarity of the realization process removes the possibility of full information.

The literary trail

It is commonly assumed (von Weizsäcker 1986, Romer 1986) that knowledge – in contrast to machine capital – does not depreciate. True, knowledge does not wear down physically from use, like machines. But its value to one firm as a capital input in production depreciates from its diffusion to other firms. True, this diffusion also speeds up the growth of the economy. Knowledge, however, also depreciates in value to its user from the creation of superior, competing knowledge. Technological competition (by my definition; Eliasson 1987) destructs the economic value of the knowledge bases on which firms operate. And modern knowledge (technology) from the past, has no economic value in today's production, except being an early state by way of which the current state of knowledge has been learned (path-dependence; Eliasson 1989b).[9]

Following Menger (1872) and Böhm-Bawerk (1881), von Weizsäcker (1986) distinguishes between three levels of economic activity; (1) Consumption, (2) Production and (3) Innovation. He establishes the important externality of innovation as the increased potential for new innovations that it creates path-dependence, and concludes that competition policy "must foster competition by innovation and must discourage competition by imitation". This, however, means halting even before Schumpeter (1912) and losing the Wicksellian (1898) and Stockholm School connection altogether. This conclusion makes von Weizsäcker add, that "the following generation of economists are called upon to undertake further research with the sagacity of a Böhm-Bawerk and the imagination of a Schumpeter, before we can speak of a definite theory of economic progress". Let me make a try. But such statements make me wonder what the generation between Schumpeter and us did.

First of all the ex ante perception of a superior commercial solution (the entrepreneurial idea) is what defines the subjective competence needed to (dare to) set up a business experiment. The hypothesis of this paper is that such entrepreneurial experiments drive the dynamics of the economy and hence macroeconomic growth. This was the idea of Smith (1776), of Schumpeter (1912) and – broadly interpreted (see

Åkerman 1952, Dahmén–Eliasson 1980) – also of Wicksell (1898). This growth process of the SSW model – as we have concluded – is necessarily experimental, since the entrepreneur is frequently wrong. Mistakes have to be counted as part of the learning cost for firms and the economy at large. There is no way of distinguishing clearly between innovation and imitation, only that both destroy (as Schumpeter contended) existing economic values. The essence of growth, hence, is the creation and depreciation ("destruction") of economically useful knowledge. That is the same as saying that a large number of business experiments have to be carried out for some, or a few successful outcomes to occur. The net outcome of the many ensuing capital gains and losses are the costs of growth. The few successes dominate the long–run movement of the entire economy. This establishes the nature of knowledge, as reflected in positive ex ante $\bar{\varepsilon}$, as the competence to create new knowledge that makes other innovations obsolescent, that also compete through the creation of new knowledge. This experimentally organized economy emerges out of the classical WAD model (Eliasson 1987, 1988a, 1990b) as state space (or the opportunity set) is made sufficiently large to make behavior boundedly rational. Tacit organizational competence arises. And free innovative entry in competition with incumbent producers is what sets the dynamics of markets on the move (Eliasson 1991). In the SSW world Say's law is contradicted and money made non-neutral, as pointed out by Morishima–Catephores (1988). The WAD model becomes useless for a wide variety of applications related to the allocation of resources. But this change of assumptions is what it takes to formulate the competitive process that moves total factor productivity growth. The reader should be aware that this is no small statement to make, even though Schumpeter said it already in 1912. In the WAD model economy, being populated by an infinite number of infinitely small actors that engage in atomistic competition, such events cannot occur.

New IO theory allows economies of scale, and hence gives a size dimension to the actors. The game of competition among the few takes place in contestable market theory, the new theory of international trade etc., but the analytical problem is still to establish static equilibrium conditions even if the wording conveys a flair of dynamics. No destruction of values occurs. The dynamic market process of Adam Smith (1776), John Bates Clark (1887), and Joseph Schumpeter (1912) cannot be derived from such mathematical structures.

3. The Firm as an Experimental, Organizational Learner

In the experimentally organized economy the idea of full information has only one meaning, namely your personalized, subjective conceptualization (hypothesis) of your external environment. This hypothesis of yours requires the implicit assumption of you that most actors (competitors) do not see what you see. This the rationale for your existence on the basis of your competence or "firm-specific knowledge". The option that your (perceived) competence might make you a winner is what makes you act.[10] This also means that many of you will frequently be fundamentally wrong, a fact that must be part of the learned knowledge base of all rational, surviving firms.

<u>Your personal view</u>

In the experimentally organized economy everybody views the world through his or her personal information or interpretation filter. This "personalized theory" determines success or failure in the market and the heterogeneity of the opportunity set. The way individuals, or teams of individuals in firms upgrade their economic interpretation filters – through trying it in the market – becomes a decisive part of the performance characteristics of the economy. This upgrading in turn depends on the compensation or incentives that come with experimental action.[11]

The individual actor looks at the world through his ex ante interpretation model that makes it possible for him to calculate and take deliberate steps. This makes firm managers take (for them) rational and deliberate steps, that to outsiders may look very daring. This is obvious from the way business firm information systems are designed (Eliasson 1990d). The ways each agent assesses its environment, and revises its theory about the environment sets the parameters of the model economy and determines the experimental path the entire economy takes. [The competence of each agent is partly composed of its ability to choose the right theory to act according to, but also on its ability to identify and correct mistakes. The first task is a matter of tacit knowledge (intuition). Analysis enters at the second control step (Eliasson 1990b)].

Joseph Schumpeter (1942, p. 123) was aware of these matters when he made double-entry book keeping one of the great discoveries of man. This device made it possible for firms to carry out rational cost and profit calculations. The financial control system of the firm became a device through which an unstructured (uncertain) business situation was converted into a situation of subjectively computable risks, an operationally meaningful proposition that may be interpreted as the foundation of the firm and be attributed to Knight (1921).[12] Coase's (1937) proposition that relative transactions costs differences in coordinating economic activities in hierarchies and in the market were the foundation of the firm, on the other hand, cannot be refuted. Coase failed to define transactions costs empirically. This is a slippery concept and Dahlman (1979) and later Wärneryd (1990), going through the implications of Coase's proposition conclude that the only transactions costs left to compare are resource losses due to imperfect information or uncertainty. In my terminology of the experimentally organized economy such "Coasian" transactions costs then must be due to mistaken business decisions. This is the same as to say that the transactions costs that hold a business together (as a team) are the costs for organizational (experimental) learning. If the firm "fails to learn more than rivals" it breaks up. This notion of the firm, based on its perceived (by the top team) competence to create intellectual order (computability) of an uncertain business situation also clarifies the largely tacit, nontradable nature of that competence. The "boundedly rational" vision of the top competent team sets the direction of the firm and defines its "competence" (Eliasson 1990b). The outsider cannot understand it.

The experimentally organized economy also makes life difficult for agents themselves. With a sufficiently large number of actors including potential entrants, each agent knows it will have to act even though it does not feel ready to act, because otherwise one or more of its competitors will come up with a better solution. Hence, mistakes will be frequent and a cost incurred to keep the growth process in motion.

This suggests that four intellectual processes must be at work simultaneously at different levels, within a business organization, namely one creative process aimed at creating the business idea or hypothesis which will ultimately determine the business rent, one analytical to monitor (test) the business experiment, one operations management process controlling physical activities and finally one learning process that feeds experience back to improve the (creative) business hypothesis. Table 1 summarizes this intellectual structure of the firm as it has to look in the experimentally organized economy. The link between 1 and 4 is the concern of this paper. The innovative process cannot be directly observed, only the outcome. The other three activities are, however, intellectually well structured, since they constitute different forms of communication and, hence, require a code for communication (Eliasson 1976, 1984a, 1990d). Similarly, even though learning (link (4) to (1) in Table 1) is mostly a "tacit" process within the top competent team of the firm, understanding it means looking for the organizational design of the process of recruitment of the talent of that team. [One should note in passing that the idea of the firm as a principal agent relationship becomes natural in the experimentally organized economy. The principal has difficulties of understanding what downstream agents do in his organization. Hence, he organizes his information system to efficiently monitor, and push their performance in terms of a well defined objective variable. I have called this internal learning game

MIP (Maintain or Improve Profits) targeting in Eliasson (1976, pp. 236 ff, 258 ff). There is, however, one type of activity that is not as easily monitored, namely the selection of innovative talent within the organization.[13] This selection at the top competent team level is much more sophisticated since it also selects those who set the objectives that control talent selection itself. Selection then becomes an integrated part of the organizational learning. This is much more fundamental than a traditional allocation problem. It includes the "joint production" (Rosen 1972) of generating both added product value and added firm specific competence, including the competence to select additional competence. How to prevent inbreeding of old competence (Smith–White 1987, Meyerson 1991) to make way for new, unknown competence, without creating chaotic internal organizational problems is no small competence demand on the top competent team.[14]]

Measured learning costs are substantial and growing as a share of total costs (Eliasson 1990a). Adding failing business experiments to the cost accounts makes learning costs very large, and – in the experimentally organized economy – largely unpredictable. Some additional insight follows from these observations. The more innovative business activity the larger the propensity to fail and the larger the (expected) proportion of learning costs incurred through mistaken decisions. Hence, the larger the ambition to aim for the small probability of a very large success, the stronger (in the aggregate) diminishing returns to learning. And the smaller the incentives to aim for them the more difficult it is to appropriate the competence acquired, i.e. to prevent imitation. The more pronounced the innovation strategy, in addition, the more important it is for the firm to develop a competence to identify and correct mistakes fast, that is to minimize costs of mistakes. These observations point in one direction, namely the growing importance of large scale organizational technique in creating, protecting and rapidly commercializing innovations in advanced industrial nations, while at the same time effectively minimizing the incurred experimental costs. In so far as it is true that creative, innovative activity cannot be efficiently organized within large firms this suggests that advanced industrial nations will have to develop the particular organizational structure needed to both effectively promote innovative work (perhaps in small firms) and effectively carry innovations to large industrial scale. This requires the parallel development of sophisticated markets for both small scale venture activities and daring venture financing needed for a viable experimental organization of the economy (Eliasson 1988b, 1990c,d).

A Generalized Salter Curve Analysis of Innovative Learning and Enforced Competition

The principal argument of section 2 for the experimentally organized economy is of cause the strongest. The realization process may, however (erroneously) be thought of as stochastic, making economic growth appear all stochastic. In this section I use the Swedish Micro-Macro (M–M) model (Eliasson 1985a, 1989b) and its selection mechanisms to show that in this non-linear Salter curve framework the stationarity assumption has to go. In another paper (1990c) I have reinforced this conclusion by showing how real firms organize their learning activities and how rapidly diminishing returns (through the costs of failure) are associated with innovative learning. The experimental organization of the economy, hence, is revealed through observing the ways its actors organize their learning.

A market, or the entire economy can at each point in time be represented by a distribution of potential performance characteristics, like the rates of return over the interest rate ($\bar{\varepsilon}$) in Figure 1.A. These types of distributions – especially if presented as productivity rankings of establishments (Figure 1.B) – are often referred to as Salter (1960) curves. Each firm is represented in this curve by a ranking on the vertical axis (the columns in Figures 1), the width of the column measuring the size of the firm in percent of all other firms. Figure 1.A shows that even though the firm indicated has increased its rate of return between 1982 and 1992 it has lost in ranking. Figure 1.B shows the same firm's labor productivity and wage cost positions. Finally, each firm has its own potential productivity frontier, under which it is operating to position itself on the productivity and rate of return rankings. This is still actual ex post performance 1982 and (simulated) 1992. The dynamics of markets on the other hand is controlled by the potential ex ante set of distributions, that capture the planned action of all other firms, including reductions in unused capacity, new entry and exit.

There is a third set of Salter curves that tell how each firm sees itself positioned relative to other firms. The real world of the experimentally organized economy, and its model approximation, the Swedish micro-to-macro model, show large divergencies between actual and perceived positions. These ex ante distributions tell the potential for the firm to outbid other firms in wages, or in paying a higher interest rate.

Learning about ones competitive situation – in reality or in theory – occurs in different dimensions. Prices offered in the market tell about how other firms – notably the best firms – view their competitive situation. Competition, production, hiring, etc. can also be directly observed. The firm learns directly when entering the market, for instance that competitors can do better. Firm management then knows that this can be done and that it had better improve in order not to be pushed down, right along the Salter distribution, and, perhaps, out. Similarly, if the firm finds itself close to the top, it knows that several "closely inferior" firms feel threatened, and are taking steps to better their positions through innovation or imitation.

If potential Salter distributions are sufficiently steep and if firms know it, firms – and especially the top left-hand group – they will feel threatened and actively aim for improving their positions on the Salter curve. If such innovative activity, notably through entry, is freely allowed, necessary conditions have been established for maintaining Salter distributions, sufficiently steep to move the entire economy through a selfperpetuated competitive process (Eliasson 1985a, 1989b). These conditions become both necessary and sufficient if state space – which I prefer to call the opportunity set

(Eliasson 1987,1990b) – is sufficiently large. This establishes the link between dynamic competition through entrepreneurship and innovative entry, argued by Smith (1776) to be the critical function behind economic growth, that perpetuates a disequilibrium economic process type Wicksell (1898). The Swedish Micro-to-Macro (M–M) model exhibits these features. Dynamic competition as described above determines entry and exit and hence the selective process that creates a path-dependent evolution, and non-stationary behavior that prevents classical learning.

The M–M model is deterministic. The M–M model "predicts" through deterministic simulation. The question on learning was whether you would be able to learn the structure of the model (to perform that prediction) from observing the output from a large number of such simulations, and with such precision that it would predict over a chosen future period, barring a stochastic error. This question reduces to the problems; (1) to find an acceptable, estimable approximation of the M–M model, and (2) to estimate the parameters of that approximate model. If (3) the error terms between the M–M simulation ("reality") and the corresponding computed model values pass a test for randomness over any chosen simulation period, classical learning is feasible. This is a major experiment to carry out even on the model. So far we have not found the time to do it. The following is, however, sufficient for my argument. The M–M model includes a large number of strong non-linearities that generate expansions and contractions of the kind that would suggest locally chaotic behavior. Endogenous entry and exit are conditioned by the market parameter settings and irreversibly move the economy along an experimental path that cannot be determined from external observations on the economy, only through knowing its full parameter setting in advance. Thus the major macro collapses that can be simulated (Eliasson 1984b) originate endogenously in the changing Salter distributions and cannot be predicted on the basis of external observations using known estimable modeling techniques (classical learning). The same collapses can be removed, for instance if entry is allowed (Eliasson

1991), a typical non-linearity that generates a path-dependent macro evolution of the macro economy. This is sufficient to rule out classical learning in the experimental setting of the M–M model.

4. Organizational Competence, Competition and Economic Growth

Competence being the ultimate, dominant capital input of a firm, its incentive system should be organized such that returns to the competence to coordinate inputs to the benefit of the owners of the firm be satisfactory. At the firm level, however, such competence has to be more broadly defined than technological competence and "being informed". The top competent team of the firm earns a profit from integrating the supply, the demand and the financing sides. Exploiting market imperfections is an important business activity and part of the value added created. Competence is, however, human or team embodied and not subject to the same contractual property rights as physical goods. It is acquired through experimental learning in the market. It is not easily tradable and difficult to learn or imitate by outsiders if they lack the requisite receiver competence. Failures are frequent. "Obsolescent" competence can rarely be replaced by crash learning or innovation programs, especially on a broad industry-wide basis. Strongly diminishing returns to learning rapidly set in due to frequent failures.

Competence coordination and monitoring is a matter of managing people with competence. It involves not only incentives to contribute but also to stay with the team. In this final section I link innovative competence to firm objectives (profits) and the creation of economic value over and above resources put in (total factor productivity growth = DTFP). I will do this mathematically in terms of the information and monitoring system of a firm as it appears in the Swedish Micro-to-Macro (M–M) model. The task is to establish a relation between the competence rents

($=\bar{\varepsilon}$), firm total productivity change (DTFP) and growth in output (DQ).

I restrict (for simplicity) measured inputs to produce output (=Q) to labor (=L) and capital ($=\bar{K}$). DX stands for the rate of change in X. Define:

$$\varepsilon = PQ - TC \tag{1}$$

$$TC = wL + (r + \rho - \frac{\Delta p^K}{p^K})K \tag{2}$$

$$R^{NE} = R^N + (R^N - r)\phi \tag{3}$$

$$R^N = M\alpha - \rho + \frac{\Delta p^K}{p^K} \tag{4}$$

$$M = 1 - \frac{w}{p}\frac{1}{\beta} \tag{5}$$

It follows immediately that:

$$\bar{\varepsilon} = R^N - r \tag{6}$$

$$pQ = TC + \bar{\varepsilon}K \tag{7}$$

R^N = nominal rate of return to total assets K

R^{NE} = nominal rate of return to net worth (E=K–D)

ρ = rate of depreciation

M = operating surplus per unit value

D = nominal debt

w = cost per unit of labor input (=L)

r = interest rate

p^K = capital goods deflator

p = value added (=Q) deflator

ϕ = D/E

α = pQ/K, capital productivity, uncorrected for relative (p,p^K) price change

β = Q/L (labor productivity)

$\bar{\varepsilon}$ is the difference between the rate of return on total assets ($=R^N$) and the interest rate (r) paid by the firm. Figure I.A shows $\bar{\varepsilon}$ to be positive or negative. But a firm cannot survive for ever with a negative $\bar{\varepsilon}$. (2) and (7) makes ($r+\bar{\varepsilon}$) the equilibrium price for capital services that exhausts total value (=PQ) product when $R^N=r$ and $\bar{\varepsilon}=0$. $\bar{\varepsilon}>0$ arises – as suggested by McKenzie (1959) – as a consequence of unmeasured capital, not included in K. This asset has a time dimension in the sense that returns come in with a delay. Even with $\bar{\varepsilon}$ negative the corresponding asset might have a large positive present value. Part of this time dimension can be interpreted as a risk factor that demands a reward (a risk premium). Positive $\bar{\varepsilon}$ might also arise out of the competence of firms to exploit imperfections in other markets. This "trading competence" is an asset in itself. If convergence prevails, firms perform a socially useful service when speculating in imperfect markets, such that prices are pushed towards equilibrium values. The cost for such Kirznerian (1973) "trading" is the speculative returns to traders.

There is a lot to say about the present value of future $\bar{\varepsilon}$. I have gone through those elaborations in Eliasson (1990b). To the extent $\bar{\varepsilon}$ measures value created by a not measured capital must have something to do with economic growth. Therefore I prove the following theorem:

$$DQ = s_1DL + s_2D\bar{K} + \frac{\Delta\varepsilon}{pQ} \quad (8)$$

<u>Proof</u>: See Appendix.

(8) tells that the rate of change in Q ($DQ=\Delta Q/Q$) is identical to a weighted average of the rates of change in labor input (DL) and capital input ($D\bar{K}$) plus the money change in excess profits ($\Delta\varepsilon$) as a share of value added. The weights are the shares of wages and capital costs respectively of value added.

(8) is an identity that expresses a profit variable in terms of a weighted average of volume inputs and outputs. To go on we need assumptions about production

technology that restricts the economy which generates these data. Many technologies are compatible with constant income shares s_1 and s_2, the most well-known being the power function (so called Cobb–Douglas) specification.

After differentiation the entire class of functions:

$$Q = CL^{S_1}K^{S_2}T \tag{9}$$

becomes (8), where the shift factor T represents exogenous disembodied technical change. Apparently from (8) and (9) total factor productivity change becomes:

$$DTFP = DT = \Delta\varepsilon/pQ \tag{10}$$

under Cobb–Douglas technology. This is enough for my purpose. I have demonstrated – for one particular production technology – that the estimated (on specification (8)) shift factor (DTFP) picks up a host of economic influences related to the allocation of resources and the exercising of competence within the firm. As a consequence the return to that unmeasured capital – that I have labeled $\bar{\varepsilon}$ – also shows up in the "technical shift factor". This competence input – by definition – also includes the ability to deal with uncertainty (successfully taking on business risks).

This technology factor, however, also picks up the competence of the entrepreneur, or trader exploiting market imperfections, for instance to successfully hire talented people at lower wages or salaries than their marginal productivities. Also capital gains will appear in ε. Since capital gains also result from trading in imperfect markets they reflect the competence of the entrepreneur to trade and should not be deflated away in productivity measurements. This competence can be exercised through the formation of synergistic teams, in which individual contributions are magnified through the exercising of top entrepreneurial competence. Scale effects originating in top entrepreneurial knowledge by definition make markets imperfect. Positive value additions to output are created, whether the firm operates as a Kirznerian equilibrator or trader or imitator, making money from moving the economy closer to equilibrium, or as a Schumpeterian entrepreneur, enhancing the productivity through changing the parameters of the system. It is not, however, universally accepted that such improvements in allocational efficiency should appear as technical change in macro production function analysis, and much work has been devoted to correct price indexes for the effects of market imperfections. (For a discussion see Färe–Grosskopf 1990, Morrison 1990).[15] This analysis, hence, merges a theory of organizational change and macroeconomic growth. Organizational learning endogenizes macroeconomic growth.

The preceding discussion raises a profound question. If imperfections in markets are fundamentally due, not to asymmetrically distributed information or slow learning or adjustment behavior, but rather to fundamental inconsistencies in beliefs, competence endowments or the formation of business judgments, actions taken on the basis of such inconsistent opinions will constantly reshape the structures that at each point in time represent the productivity characteristics of the firm or the economic system, that in turn shape future ex ante perceptions of what is to come and so on. The path the economy takes will generate ex ante/ex post realizations that will be reflected in the shift factor DTFP in (10) as positive or negative contributions to output. This essay has been devoted to showing that the use of economic knowledge embodied in the organization of the firm or the economy, notably the organization of human competence, determines the character of these value contributions. The ultimate organizational technology of a nation then becomes the art of organizing itself, such that these value added contributions are steadily positive. Then economic growth occurs.

Appendix: Proof of (8)

From (1) and (2);

$$PQ = wL + (r + \rho - \frac{\Delta p^K}{p^K})K + \varepsilon$$

Take differences, assuming (p, w, r, p^K) fixed;

$$P \cdot \Delta Q \equiv w\Delta L + [\quad]\, p^K \Delta \bar{K} + \Delta\varepsilon$$

Thus;

$$\frac{\Delta Q}{Q} = DQ \equiv \frac{wL}{pQ}DL + \frac{[\quad]\ \Delta p^K \bar{K}}{pQ} \cdot D\bar{K} + \frac{\Delta\varepsilon}{pQ}$$

$$DQ = S_1 DL + S_2 D\bar{K} + \frac{\Delta\varepsilon}{pQ}$$

$$S_1 = \frac{wL}{pQ}$$

$$S_2 = \frac{[r + \rho - \frac{\Delta p^K}{p^K}]p^K \bar{K}}{pQ}$$

Q.E.D.

Table 1 The intellectual structure of the firm

1. **Innovation;**	Creating the business hypothesis (setting up the experiment)
2. **Analysis;**	Monitoring performance against the hypothesis – identification of mistakes – correction of mistakes
3. **Operations;**	Managing physical production, once business viability has been established under (2)
4. **Learning;**	Experience feed back to (1)

Source: Eliasson (1990b).

Figure 1 Performance characteristics of one firm in relation to a population of firms

Figure 1.A <u>Rate of return over the interest rate ($\bar{\varepsilon}$) distributions 1982, 1992 and 2002</u>

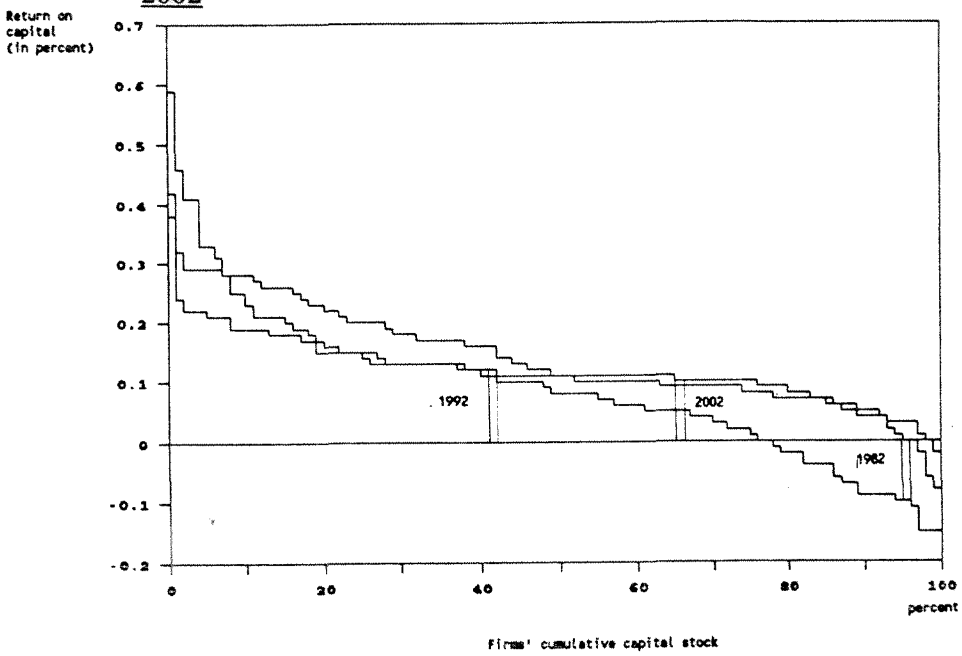
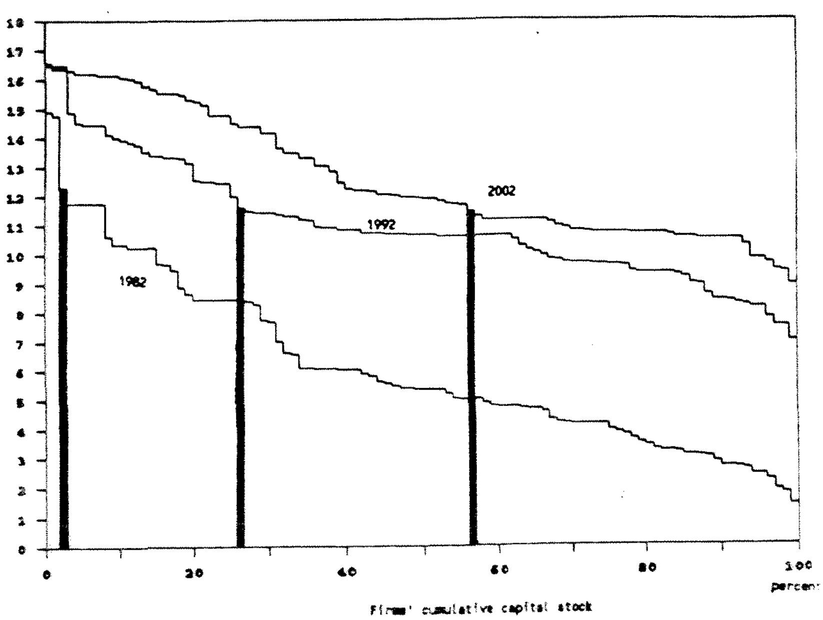


Figure 1.B <u>Labor productivity distributions 1982, 1992 and 2002</u>



<u>Source</u>: Experiments on Swedish Micro-to-Macro model.

Bibliography

Anderson, G.M.–Tollison, R.D., 1982, Adam Smith's Analysis of Joint-Stock Companies, *Journal of Political Economy*, Vol. 90, December, pp. 1237–1256.

Arrow, K.J., 1959, Toward a Theory of Price Adjustment; in Abramowitz, M. et al. (1959), *The Allocation of Economic Resources*, Stanford, Calif.

Arrow, K.J., 1962, The Economic Implications of Learning by Doing, *Review of Economic Studies*, Vol. 29, June, pp. 155–173.

Blume, L.E.–Easley, D., 1982, Learning to Be Rational, *Journal of Economic Theory*, Vol. 26, pp. 340–351.

Bray, M., 1982, Learning, Estimation, and the Stability of Rational Expectations, *Journal of Economic Theory*, Vol. 26, pp. 318–339.

Böhm–Bawerk, E. von, 1881, *Rechte und Verhältnisse vom Standpunkte der Volkswirtschaftlichen Güterlehre*, Innsbruck.

Clark, J.B., 1887, The Limits of Competition, *Political Science*, Vol. 2, No. 1, pp. 45–61.

Coase, R.H., 1937, The Nature of the Firm, *Economica*, Vol. IV, November, pp. 13–16.

Dahlman, C.J., 1979, The Problem of Externality, *Journal of Law and Economics,* pp. 141–162.

Dahmén, E.–Eliasson, G., 1980, Företagaren i det ekonomiska skeendet (The Entrepreneur in the Market Environment); in Dahmén, E.–Eliasson, G. (eds.), *Industriell utveckling i Sverige. Teori och verklighet under ett sekel* (Industrial Development in Sweden. Theory and Practice during a Century), IUI, Stockholm.

Day, R.H.–Eliasson, G. (eds.), 1986, *The Dynamics of Market Economies*, IUI, Stockholm and North-Holland, Amsterdam.

Eliasson, G., 1967, *Kreditmarknaden och industrins investeringar*, IUI, Stockholm.

Eliasson, G., 1969, *The Credit Market, Investment, Planning and Monetary Policy – An Econometric Study of Manufacturing Industries*, IUI, Stockholm.

Eliasson, G., 1976, *Business Economic Planning – Theory, Practice and Comparison*, John Wiley & Sons, London, New York, Sidney, Toronto.

Eliasson, G., 1984a, Informations- och styrsystem i stora företag (Information and Control Systems in Large Business Organizations); in Eliasson–Fries–Jagrén–Oxelheim, *Hur styrs storföretag? En studie av informationshantering och organisation* (How Are Large Business Groups Managed? A Study of Information Handling and Organization), IUI – Liber, Kristianstad, 1984.

Eliasson, G., 1984b, Micro Heterogeneity of Firms and the Stability of Industrial Growth, *JEBO*, Vol. 5, Sept.-Dec.

Eliasson, G., 1985a, *The Firm and Financial Markets in the Swedish Micro-to-Macro Model – Theory, Model and Verification,* IUI, Stockholm.

Eliasson, G., 1985b, De svenska storföretagen – en studie av internationaliseringens konsekvenser för den svenska ekonomin; in *De svenska storföretagen* (The Giant Swedish Multinationals), IUI, Stockholm.

Eliasson, G., 1986, Kompetens, kommunikation och kunskapsuppbyggnad (Competence, communication and knowledge accumulation); in Eliasson, G. et al. (1986), *Kunskap, information och tjänster*, IUI, Stockholm.

Eliasson, G., 1987, *Technological Competition and Trade in the Experimentally Organized Economy*, IUI Research Report No. 32, Stockholm.

Eliasson, G., 1988a, Schumpeterian Innovation, Market Structure and the Stability of Industrial Development; in Hanusch (1988).

Eliasson, G., 1988b, *The International Firm: A Vehicle for Overcoming Barriers to Trade and a Global Intelligence Organization Diffusing the Notion of a Nation,* IUI Working Paper No. 201, Stockholm.

Eliasson, G., 1989a, The Dynamics of Supply and Economic Growth – how industrial knowledge accumulation drives a path-dependent economic process; in Carlsson, B. (ed.), 1989, *Industrial Dynamics*, Kluwer Academic Publishers, Boston/Dordrecht/London.

Eliasson, G., 1989b, *Modeling Long-Term Macroeconomic Growth as a Micro-Based, Path Dependent, Experimentally Organized Economic Process*, IUI Working Paper No. 220, Stockholm.

Eliasson, G., 1989c, *The Economics of Coordination, Innovation, Selection and Learning – a theoretical framework for research in industrial economics*, IUI Working Paper No. 235, Stockholm.

Eliasson, G., 1990a, The Knowledge Based Information Economy; in Eliasson–Fölster–Lindberg–Pousette–Taymaz (1990).

Eliasson, G., 1990b, The Firm as a Competent Team, *JEBO*, Vol. 13, No. 3, June.

Eliasson, G., 1990c, *A European Market for Managerial Competence*; paper presented at the conference on "Financial Regulation and Monetary Arrangements after 1992" in Marstrand, Sweden, May 20–24 1990.

Eliasson, G., 1990d, The Firm, Its Objectives, Its Controls and Its Organization, IUI Working Paper No, 266, Stockholm.

Eliasson, G., 1991, Deregulation, Innovative Entry and Structural Diversity as a Source of Stable and Rapid Economic Growth, *Journal of Evolutionary Economics,* No. 1, pp. 49–63.

Eliasson, G.–Fölster, S.–Lindberg, T.–Pousette, T.–Taymaz, E., 1990, *The Knowledge Based Information Economy,* IUI, Stockholm.

Fama, E.F. et al., 1969, The Adjustment of Stock Prices to New Information, *International Economic Review*, Vol. 10, Feb., pp. 1–21.

Fourgeaud, C.–Gourieroux, C.–Pradel, J., 1986, Learning Procedures and

Convergence to Rationality, *Econometrica*, Vol. 54, No. 4, July, pp. 845–868.

Frydman, R., 1982, Towards An Understanding of Market Processes; Individual Expectations, Learning, and Convergence to Rational Expectations Equilibrium, *American Economic Review*, Vol. 72, No. 4, pp. 652–668.

Färe, R.–Grosskopf, S., 1990, Theory and Calculation of Productivity Indexes: Revisited. Mimeo. Department of Economics, Illinois University.

Haavelmo T., 1944, The Probability Approach in Econometrics, *Econometrica*, Vol. 12, Supplement, July.

Hanusch, H. (ed.), 1988, *Evolutionary Economics – Applications of Schumpeter's Ideas*, Cambridge University Press, Cambridge, New York etc.

Harris, M.–Holmström, B., 1982, A Theory of Wage Dynamics, *Review of Economic Studies*, Vol. XLIX, pp. 315–333.

Hirschleifer, J., 1971, The Private and Social Value of Information and the Reward of Inventive Activity, *American Economic Review*, Vol. LXI, No. 4, pp. 561–574.

Holmström, B., 1982a, Moral Hazard in Teams, *Bell Journal of Economics*, Vol. 13, No. 2, pp. 324–340.

Holmström, B., 1982b, Managerial Incentives – A Dynamic Perspective, in *Essays in Honor of Lars Wahlbeck*, Helsinki: (Swedish School of Economics).

Keynes, J.M., 1921, *A Treatise on Probability*, McMillan and Co., London.

Kirzner, I., 1973, *Competition and Entrepreneurship*, University of Chicago Press, Chicago.

Knight, F., 1921, *Risk, Uncertainty and Profit*, Houghton-Mifflin, Boston.

Lazear, E.P., 1981, Agency, Earnings Profiles, Productivity and Hours Restrictions, *American Economic Review*, Vol. 71, No. 4, pp. 606–620.

Lindh, T., 1989, Lessons from Learning about Rational Expectations, IUI Working Paper No. 238, Stockholm.

McKenzie, L.N., 1959, On the Existence of General Equilibrium for a Competitive

Market, *Econometrica*, Vol. 27, No. 1, pp. 30–53.

Menger, C., 1872, *Grundsätze der Volkswirtschaftslehre*, Vienna.

Meyerson, E., 1991, *The Recruitment Processes for Leadership – Internal Dynamics and External Control*, University of Stockholm, Dissertation at the University of Stockholm.

Mill, J.S., 1848, *Principles of Political Economy with Some of Their Applications to Social Philosophy*, London.

Modigliani, F.–Cohen, K., 1961, *The Role of Anticipation and Plans in Economic Behavior*, University of Illinois Press, Urbana.

Morishima, M.–Catephores, G., 1988, Anti-Say's Law versus Say's Law: A Change in Paradigm; in Hanusch, H. (ed.) (1988).

Morrison, C.J., 1990, *Market Power, Economic Profitability and Production Growth Measurement; An Integrated Structural Approach*, NBER Working Paper No. 3355.

Palander, T., 1941, Om "Stockholmsskolans" begrepp och metoder, *Ekonomisk Tidskrift*, Årgång 43 (1941:1), pp. 88–143.

Pelikan, P., 1989, Evolution, Economic Competence, and the Market for Corporate Control, *JEBO*, Vol. 12, Dec., pp. 279–303.

Reinganum, J., 1989, The Timing of Innovation, Research, Development and Diffusion; in Schmalensee, R.–Willig, R. (eds.), *Handbook of Industrial Organization*, North-Holland, Amsterdam.

Ricart i Costa, J.E., 1987, *On Managerial Contracting with Asymmetric Information*, Paper presented to the EARIE Conference in Madrid, August 31–September 2, 1987 (mimeo).

Romer, P.M., 1986, Growth Based on Increasing Returns and Long-term Growth, *Journal of Political Economy*, Vol. 94, No. 5, pp. 1002–1037.

Rosen, S., 1972, Learning by Experience as Joint Production, *Quarterly Journal of*

Economics, Vol. LXXXVI, No. 3, pp. 366–382.

Rosen, S., 1981, The Economics of Super Stars, *American Economic Review,* Vol. 71, No. 5.

Rosen, S., 1982, Authority, Control and the Distribution of Earnings, *Bell Journal of Economy*, Vol. 13, No. 2, pp. 311–323.

Rothschild, M., 1974, A Two-Armed Bandit Theory of Pricing, *Journal of Economic Theory*, Vol. 9, pp. 185–202.

Ruist, E., 1950, Vad är produktivitet? (What is productivity?); in *Industriproblem 1950*, IUI, Stockholm.

Ruist, E., 1960, *Industriföretagets produktionseffektivitet. Några mätningsmetoder* (Production efficiency of the of the industrial firm. Some methods of measurements), IUI, Stockholm.

Salter, W.E.G., 1960, *Productivity and Technical Change*, Cambridge University Press, Cambridge.

Schumpeter, J.A., 1912 (english edition 1934), *The Theory of Economic Development*, Harvard Economic Studies, Vol. XLVI, Harvard University Press, Cambridge, Mass. (Originally published in German.)

Schumpeter, J.A., 1942, *Capitalism, Socialism and Democracy*, Harper & Row, New York.

Smith, A., 1776, *An Inquiry into the Nature and Causes of the Wealth of Nations*, Modern Library, New York, 1937.

Smith, M.–White, M.C., 1987, Strategy, CEO, Specialization and Success, *Administration Science Quarterly*, Vol. 32, pp. 263–280.

Stigler, G.J., 1961, The Economics of Information, *Journal of Political Economy*, Vol. 69, No. 3, pp. 213–225.

Wallis, K.F., 1980, Econometric Implications of the Rational Expectations Hypothesis, *Econometrica*, Vol. 48, No. 1, January.

von Weizsäcker, Ch., 1986, Rights and Relations in Modern Economic Theory; in Day, R.–Eliasson, G. (eds.) (1986).

Westerman, J., 1768, *Om de svenske näringarnes undervigt gentemot de utländske dymedelst en trögare arbetsdrift* (On the inferiority of the Swedish compared to foreign manufacturers because of a slower work organization), Stockholm.

Wicksell, K., 1898, *Geldzins und Güterpreise* (English translation: Interest and Prices), published by AMK Bookseller, New York 1965.

Wärneryd, K., 1990, *Economic Conventions: Essence in Institutional Evolution*, EFI, The Stockholm School of Economics, Stockholm.

Åkerman, J., 1952, Innovationer och kumulativa förlopp (Innovations and Cumulative Economic Developments), *Ekonomisk Tidskrift*, pp. 185–202.

Notes

[1] This paper has been through several stages of revision. Along the way many people have contributed critical remarks, enthusiastic support and observations. I want to thank Pontus Braunerhjelm, Bo Carlsson, Bill Comanor, Christina Hartler, Jonas Häckner, Thomas Lindh, Erik Mellander, Karl Markus Modén, Pavel Pelikan and Frank Stafford in particular. Whatever errors that remain are, however, entirely of my own making.

[2] This little book, in fact, contains an early formulation of the economic efficiency of national work specialization and the benefits of trade. Westerman suggested to the King of Sweden that more of that be promoted.

[3] This also means that an equlibrium point – if it exists – cannot be computed. It has to be approached through search (experimentation). Since search is costly, the existence of equlibrium will depend on whether search costs are computable. The answer is part of the story of this paper.

[4] Note, however, that Wicksell was mostly concerned with (cumulative) inflation. His proposition about the source of inflation can, however, be extended to cover economic growth. See Åkerman (1952) and Dahmén-Eliasson (1980).

[5] Most analyses assume stationarity. There are, however, attempts to break through this restrictive assumption. See Wallis (1980). To avoid "technical misunderstanding" please note that both §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 normally been assumed to be zero. See, however, Fourgeaud–Gouriecroux–Pradel (1986) who make the equilibrium dependent on the learning process.

[6] Standard, rational expectations based learning within the WAD framework may even be theoretically impossible. First, the specification of the "boundedly rational" decision models may be both different and misspecified. Then the parameters of the underlying distributions of fundamentals cannot be estimated by the agents. This becomes obvious if we remember that these distributions themselves represent, at each point in time, the combined behavior of all biased decisions in the economy. Second, to be able to make a decision, or operate a "seemingly estimable" decision system, the information–decision model has to be reasonably simple, and, hence, as a rule misspecified. If you, however, formulate a realistic interpretation and decision model, it will soon take you outside the domain of estimation techniques that give unbiased parameter estimates.

[7] In fact as an "insurer" on the basis of subjective probability. Cf Keynes (1921).

[8] Rotschild (1974) gives a very simple example of how path dependence can arise in a classical search market setting, even though he doesn't use the term. A gambler faces the problem of deciding which of two one-armed bandits to play, about one of which (the first) he believes he knows the probabilities of gain and loss. Whenever trying the second machine about which he knows nothing, he compares the random drawing with what he believes of the first machine, and accordingly revises his expectations about which machine is the best. As a consequence his choice of machine will depend on the sequence of random drawings he happens to pick. This is a typical example of path-dependence. In the micro-macro model (see below) similar path-dependence arises out of – among other things – the differential entry and exit patterns that depend on the market regime parameter settings, which correspond to the probability parameters of the one-armed bandits.

[9] It is instructive to compare this dynamic view of the experimentally organized economy with the conclusion of overinvestment in R&D of Hirschleifer (1971), and in a number of recent R&D race models (for an overview, see Reinganum 1989), based on

the classical model. The overinvestment argument has to be based on the assumption that there is only one optimal solution that you can either identify analytically or recognize (as the best) when you find it. Suppose, on the other hand, that "best" is not well defined, and that you will have to compare what is offered with other solutions in order to determine what is best. Then overinvestment in R&D is a necessary condition for finding the best solution, and a standard information cost of creating successful innovations (see next section). Worse still is that however many search investments you make, you can never be sure that you have found the best solution, provided you have made state space (the "urn") sufficiently large or irregular. If you have only one mountain in state space there are efficient algorithms for going to the top, but if you are in a mountain range it is quite another matter to find the highest top.

[10] If all agents perceived your opportunity to earn a rent, the opportunity would be competed away ex ante, and the classical model would require that you also saw that. There would be no ex ante reason to act. Hence nobody would act, hence there would be a reason to act, hence if everybody etc. Perfect information diffusion gives rise to paradoxes.

[11] All well as on the perceived risks.

[12] Even though it is somewhat unclear whether Knight really intended this interpretation. See Eliasson (1990b).

[13] Some partial aspects of this have been studied analytically as an allocation problem in the management hiring and compensation literature (e.g. Holmström 1982a,b, Harris–Holmström 1982, Ricart i Costa 1987).

[14] The notion of learning and competence accumulation as the source of competitive performance in the experimentally organized economy also makes it natural to reinterpret Lazear's (1981) lifetime employment compensation idea in terms of

learning, and view the firm as a habitat of risk averse, but competent employees, who buy insurance for future variations in their income streams from the risk willing owner/entrepreneur, by accepting a lower wage than their marginal productivity contributions, and an upward tilting of their compensation schedule as an unemployment insurance, retirement scheme, with late payouts. Organizational competence, however, does not only include the task of organizing profitable internal insurance for talented but risk averse labor, but also the short-term exploitation of internal scale economies by executive "superstars" (Rosen 1981, 1982). The experimentally organized economy requires risk willing agents capable of converting an uncertain situation onto an insurable footing and/or agents that act to protect their wealth. Most human beings lack the capacity to act independently in this environment and are in the market trading work input for income and protection. The employment and compensation contract gives this protection but also serves the purpose of locking in both the humans and their talent in a team for considerable time (Eliasson 1990b).

[15] Assume equilibrium prices. A new ompetitive situation is reflected in a new set of equilibrium prices, and all quantities adjust to this new price configuration along the production frontiers. This is the method of computable equilibrium modeling. The a priori restriction on production technology usually demands a particular price index to leave the shift factor (DTFP) invariant to such adjustments.