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The Role of Knowledge in Economic Growth

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1. Introduction – opening up the knowledge box

Figure 1 sets the stage for our discussion. The kink of the curve signifies the ”onset” of an important historical process, commonly called the industrial revolution. Around that kink a number of events took place. First of all, and probably most important (Eliasson 1991c) the production system of Sweden and the now industrialized mature economies was thoroughly deregulated by the rapid removal of the craft system. Parallel to this, however, significant investments in public schooling were initiated, Also, and third, at that time the new technology of the industrial revolution, based on the invention and increased sophistication of the machine tools since the second half of the 18th century in England was rapidly being introduced among the now mature industrial economies, allowing for fundamental reorganization of production. Great opportunities were created, but even though the new technology was to a large extent internationally available, only a handful of countries made it onto the faster growth track, under significant social disruption and effort. The local ability to put the new technology to industrial use (*Receiver competence*, Eliasson 1990a) mattered. Since that time and until recently a diminishing income inequality could be observed in the industrializing economies, as people left agriculture and the handicrafts to earn higher and steadily increasing wages in firms enjoying, for a long time, steadily increasing returns. Several questions can be asked. The important one today is what kind of knowledge capital played the role of a moving force behind this development.

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This knowledge capital has to be broadly defined to explain what happened, including the social capital that facilitated, or allowed the radical change in the circumstances of the ordinary citizen that took place. Another question is: Is something similar happening now, as we enter the New Economy?

The heavy line in Figure 1 suggests one explanation. During that period 17 out of the 32 largest manufacturing firms[2] that still dominate Swedish manufacturing industry were started. Can we observe a similar and promising surge in radically new firm establishment today that forebodes a new economy? If so what kind of human capital is moving that change and what kind of social capital will accommodate the individual sacrifices associated with the same change. In saying so we have introduced a narrow definition of social capital that can be fairly clearly explained as to functionality. It has some similarity with what Jozef Ritzen (2001) calls ”social cohesion”. I argue, that we should begin there, before broadening the concept of capital beyond the limits of measurement. The purpose has to be understood before a meaningful definition of its sources should be attempted.[3]

Describing and representing growth statistically is now standard economics in various forms of macro production function analysis, including new growth theory. There is always a way of proxying in a performing measure of knowledge in the econometric equations. Understanding the role of knowledge in growth (Abramowitz 1988) is more difficult. You then have to open up the macro box called technology and let all the actors out in their capacity of being carriers of competence (dynamics). You also have to open up the Keynesian demand box to allow the customers to play the roles of competence contributors and final arbiters of value that they play in reality. After that we may not be able to close the box again. Or

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[2] The 15 largest firms in 1945, 1983 and 1990, together 32, still (1990) account for 33 percent of Swedish exports and almost 50 percent of assets on the Swedish stock exchange (Eliasson and Johansson 1999, pp. 48 ff).

[3] Here I am skeptical about Woolcock’s (2001) argument that one should begin with the sources. Defining a general purpose social capital on the basis of presumed sources will make it close to impossible to clarify its functional role in, for instance, the growth process. See Eliasson (1999b) on making intangibles visible and (1994c) on the definition of knowledge capital in economic growth. For instance, on knowledge in general, it becomes too easy to create a prior vision (by assumption) that school (one of many sources) is all that matters for growth when it comes to the knowledge input in the growth process.

should we continue to assume that the nature of the behavioral dynamics within the box has no influence on the macro development that we describe statistically in neoclassical production function econometrics. Of course not. If we want to understand we have to look inside, and represent the complicated dynamics between more or less autonomous behaving (and live) actors with a varied assortment of embodied competencies at the micro market level. This is the macro development that we *describe* by statistical methods, but that requires a dynamic micro-to-macro *explanation*.

So I will break open the macro box of new growth theory (Romer 1986, 1990) to find the Marshallian (1890, 1919) ”industrial district”, and the demand box to find active customers that contribute to product quality development. I will then populate those theoretical boxes with live actors with competence to build a model of growth through competitive selection. Marshall had the same problem as Romer, namely to make the necessary conditions (for equilibrium) in the Walrasian model, i.e. decreasing returns, compatible with the standard empirical observation of increasing returns and growth. The solution of Marshall, as well as that of Romer, was a collective or infrastructure district effect, or a technological spillover system (Nadiri 1978, 1993) to use modern terminology.

At each point in time each actor in the industrial district was assumed by Marshall (1890) and Romer (1986, 1990, who kept himself at the macro surface) to experience decreasing returns. Over time, however, their individual decisions raised the collective infrastructure knowledge capital, such that continuing long-run increasing returns could be observed. In the short term, however, steeply decreasing returns to learning or building infrastructure knowledge capital had to be assumed to secure an interior equilibrium.

Neither Marshall nor Romer discussed the live and unpredictable actors inside the district or the macro box and how they kicked and pushed the entire system. This is necessary to endogenize economic growth. This is what I will do by introducing the enormous complexity and vastness of the *knowledge based information economy* (Eliasson 1987b, 1990b, OECD 1995), the selective dynamics of the *Experimentally Organized Economy* (EOE; Eliasson 1987a, 1991b, 1992) and its component part, *competence bloc theory* (Eliasson and Eliasson 1996, Eliasson 1998c). The former features every activity as a business experiment based on local competence that is insufficient to control the outcome, making business mistakes a standard cost for economic development and *learning*. The latter explains how this selection and learning can be organized efficiently, i.e. such that the incidence of two types of business errors is minimized. The two errors are (1) to keep losers on for too long and (2) to lose the winners. And the solution is to expose each project to a maximum of varied competence (evaluation). Two categories of collective knowledge capital emerge from this observation. The first category is the dominant competence capital (Eliasson 1989) distributed over and embodied in individuals and firms that has to enter economic analysis. Key to understanding is how the knowledge base of the economy is organized for efficient selection. Implicit in this observation is that the value (”size”) of the knowledge base becomes dependent on its allocation. The beauty of competence bloc analysis (within the EOE) is that the role of tacit, incommunicable knowledge or competence (Eliasson 1990a) can be explicitly dealt with through *organization*. Knowledge does not have to be functionally defined. The carriers are identified instead. Organization enters as a separate competence category (Eliasson 1992). Organization and endogenous organizational change (organizational learning/dynamics) are much neglected phenomena in mainstream economics. And the reason is very simple and human. If allowed in, it inevitably uproots the standard mathematical structure of the neoclassical model, which one should of course avoid, if one has nothing to offer instead.

The effects of the dynamics created by growth through competitive selection inevitably spills into the social dimension of the economy, notably the labor market. Individuals have to be equipped with a particular social capital to accept and cope with change, a local change that is largely unpredictable and arbitrary as seen by the individual.

2. Departure from the neoclassical paradigm into the Knowledge Based Economy

The departure from the neoclassical paradigm is not that large in principle, but significant in its implications. Most simply expressed; we keep the standard convexity assumptions of the Walras-Arrow-Debreu (WAD) or neoclassical model, but do not impose Walrasian market clearing. Then we do not have to bother about the continuity assumptions that analysts of the WAD model need to secure a unique equilibrium. The interesting question is what giving up the market clearing assumption means for the existence of an exogenous equilibrium and classical price taking behavior of agents. Both vanish, and really, we don't want the static equilibrium as traditionally defined. What we lose from abandoning static equilibrium is analytical simplicity. But this is good and healthy. As economic advisors we (the economists) then do not get fooled by the a priori assumptions of our theoretical tools into believing that we know more about the real economy than we really do. This insight is long overdue in view of the enormous, and close to disastrous influence the professional economists have occasionally had on policy making (Eliasson 1998c, 2000a, Eliasson and Taymaz 2000). Summarizing, the axioms of both the WAD and the EOE models are shown in Table 1.

(Table 1 in about here)

The state space of the WAD model is very small, sufficiently small to make explicit profit and utility maximization possible. In the WAD state space actors are locked in place in equilibrium. There is no room for any form of autonomous (”live”) behavior. Institutions regulating access to state space have no analytic meaning. Such things as entry or exit do not occur.

In the knowledge based information economy (Eliasson 1987a, 1990a, b), however, the state space is extremely large and complex, sufficiently large to preclude any form of overview from one point. I call it the business opportunity space. Hence, optimization in the WAD full information (or almost so) sense is precluded (*by realistic assumptions*). Firms do strive for maximum ex ante profits, but never reach that state, partly because the ex ante optimum is a subjective perception of each actor and partly because searching for it draws resources. Hence, their decisions are fraught with error, *business mistakes becoming a standard cost for economic development*. These business errors should not be assumed to be random

(Knight 1921, Eliasson 1990a). They constitute information costs in the economy that are influenced by technological change and affect its equilibrium properties (Eliasson 1991b). Market clearing is possible neither in a deterministic nor in a rational equilibrium sense.

Even an enormous state space would eventually be ”penetrated” and made transparent under the assumptions of the WAD model. Simply speaking, if there are no (or sufficiently small) transactions costs, actors go on searching for information using some form of statistical learning method (Lindh 1993). This option is precluded in the knowledge based information economy. *First*, information and communications costs are demonstrated to be (Eliasson 1990a, b) dominant, accounting for at least 50 percent of production costs in manufacturing and an even higher share at the GNP level. This being the case an equilibrium trajectory, however defined, will be dependent on information and communication costs and, hence, on information and communications technology change, that is change in the technology of search. It then becomes meaningless to construct models with simple exogenous and analytically determinable equilibria.

But this is a technical detail. Mathematicians are uncomfortable with open-ended state spaces. They want them closed from above by outside forces. Hence, the possibility is always there, that some bold explorer or an assumed Walrasian superauctioneer will eventually find the optimal place, however large state space is. State spaces in economics, however, should not be assumed to be given data. We may realistically argue that they are extremely large at each point in time, and impossible to survey more than fractionally (by each agent) at each point in time. But assume realistically that the *business opportunity space is limited by the unknown sum total of all knowledge of each actor in the state space and all possible useful, but even more unknown combinations of the same knowledge* (Eliasson 1987a, 1990b, 1992, 1999b).[4] Then search into the same state space for more investment opportunities will create new opportunities (new combinations with so far not discovered combinations*).* *State space keeps*

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[4] Even though unfamiliar to economists, this notion of state space is not new to philosophy (Eliasson 1996, 16 f.). If we define the opportunity set as the total knowledge of all possible, but still unknown contributors of knowledge we adopt the notion of state space popularized by the philosophers of the age of enlightenment. David Hume and John Locke discussed the world in terms of (1) *memory*, (2) *logics* and (3) *imagination*. Leibniz, however, accepted no more imagination than all possible *logical* permutations of *facts* (”memory”; see Eliasson 1996, 16 f.), the reducibility presumption.

expanding from learning. This is true in the Joseph Schumpeter model I from 1911. The state space grows from being exploited. I have called this the *Särimner effect* (Eliasson 1987a, 29; 1991b, 1992) from the pig in the Viking saga that was eaten for supper, but returned again next evening to be eaten again. *In the experimentally organized economy* that we now enter, the pig even increases in size from being eaten. *We have a potential positive sum game*, which is needed to formulate endogenous growth theory.

3. The Experimentally Organized Economy (EOE)[5]

In the EOE full penetration of state space for optimal positioning by all agents is impossible at each point in time, and (because of learning) at each future point of time.

In the EOE each agent sets up a business experiment that is tested in the market in a confrontation with all other agents, that is frequently found to be a business mistake. In the EOE, hence, room is made for autonomous behavior in the sense of Table 1 and access to state space is regulated by institutions carrying an economic meaning. In fact, the competence of a firm is best characterized as in Table 2.

(Table 2 in about here)

Table 2 represents a typical situation of a firm in the EOE (Eliasson 1996, p. 56; 1998a, p. 87). *First* of all, no actor, including Government, can survey the entire opportunity set from one point. It is not transparent and business mistakes will be made by all actors all the time. Such mistakes

[5] The micro based macro model of the Swedish economy that I will refer to below approximates the EOE.

should be regarded as a normal cost for economic development. *Second*, some actors may hit the absolutely best solution by pure chance, but they will never know, and nobody else either. Hence, *third*, the economy will always be operating far below its production possibility frontier, thus violating a standard assumption of neoclassical theory.

Fourth, as a business actor you must always believe in your proposed business experiment. If not, you cannot act decisively and forcefully. *Fifth*, however, whatever you have invented you know one thing with almost certainty; there will be many potential solutions that are much better. Therefore, and *sixth*, you have to recognize that among your many competitors you cannot be alone with such a good idea as yours. You have to act decisively and prematurely on the basis of your competent judgement (*intuition*) before somebody else has acted successfully. Each new solution, therefore, has the character of a business experiment, and the competence of a business firm is well categorized in Table 2.

4. Growth through competitive selection

When something radically new is introduced it almost always occurs through the launching of a new product, the establishment of a new division or through the entry of a new firm. When sufficiently radical you don’t reorganize and accommodate but scrap and establish. A new product may be a complement to existing products or a substitute, in the latter case subjecting existing producers to competition and forcing them to reorganize and/or rationalize, or die (exit). The entry process, hence, is critical for economic growth, pushing performance of the entire industry upwards through the four selection and growth mechanisms (”investments” of Table 3).[6]

[6] This reasoning can be nicely illustrated using a Salter (1960) curve. See Eliasson (1996, 44 f.). This is also the way growth occurs in the Swedish micro-to-macro model (Eliasson 1991b). It is particularly important to observe that innovative entry subjects incumbent firms to competition and forces them to respond. The response in the form of

(Table 3 in about here)

Having said this much we are far outside the domain of WAD theory. We are discovering endogenous organizational change, notably through entry and exit at all levels, as the mover of economic development. We know from a few studies that the productivity effects at the firm level from radical reorganizing are sizable. We know from simulation analyses on a micro-to-macro model approximating the EOE that reorganization and reallocating resources among firms, including new entry and exit, can generate very large long-term effects on economic growth (see further Section 7). This is true micro-to-macro dynamics, which will be an even stronger moving force in the ”New Internet Economy”. But things can also be done wrong at all levels, and result in stagnation or decline instead. This means that the selection and allocation to deliver positive growth have to be organized efficiently. This also requires competence.

5. Competence bloc theory

Efficient selection means minimizing the incidence of two types of errors (Table 3), i.e. keeping losers on for too long and losing the winners. It is an organizational solution to the allocation of tacit, human embodied competencies.

The role of competence bloc theory (G. Eliasson and Å. Eliasson 1996, Eliasson 1997a, 1998c) is to explain these competitive selection processes that generate growth in the experimentally organized economy (Eliasson 1991b, 1996). When efficiently organized, the competence bloc organization minimizes the incidence of the two types of errors. One can also say that increasing returns prevail to search by potential winners. The

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reorganization and rationalization may mean both expansion and contraction depending upon incentives embedded in the institutions of the economy and the individual competence capital of firms.

basic rationale of competence bloc theory is that it is more important economically to do the right things than to do what you do efficiently. Hence, customer satisfaction and (to be shown) customer competence contributions are in focus. While the traditional Walras-Arrow-Debreu model ”embodies” only one (optimal) equilibrium solution without choice, the EOE offers an incomprehensible variety of choices and ways of organizing this selection. Competence bloc theory, hence, is an analytical device to explain this organization and the development of an industry driven by the complex interaction of competent actors, the competence of whom to perform particular tasks (functions) cannot be defined (specified) as to content, only be characterized as to results (output). I here outline the characteristics needed and used in this analysis. The minimum set of competent actors of the competence bloc is exhibited in Table 4.

The EOE and competence bloc theory together define the dynamics of endogenous growth. Together the two explain how the technologies needed to build a new industry are:

- created (*innovation*)
- identified (*recognition*)
- selected (*competition*)
- commercialized and diffused (*market support*) and
- competently introduced in production (*receiver competence*)

such that the right (product) technology choices are made and the two types of errors (Table 5) are minimized, i.e. (1) to keep losers for too long and (2) to reject winners. In an efficiently organized and well-staffed (with competence) competence bloc *potential winners are exposed to a maximum of varied competencies such that they experience increasing returns to continued search*. In the selection process two types of phenomena appear;

(a) synergies and spillovers arise (Eliasson 1997a, 1998b, c), (b) business mistakes appear as the necessary consequences of a learning process and figure as a standard cost for economic development (Eliasson 1992).

The innovation and selection process in the competence bloc (through Table 4) is organized as follows:

First, the products chosen or created in the process never get better than what *customers* are capable of appreciating and willing to pay for. The long-term direction of technical change, therefore, is always set by the customers. This is so even though the innovator, entrepreneur or industrialist takes the initiative. But quite often the customer takes the initiative. Technological development, therefore, requires a sophisticated customer base (Eliasson 1998a, G. Eliasson and Å. Eliasson 1996). In one sense, the customer analysis of competence bloc theory opens up the Keynesian macro demand schedule. But as you peek inside that ”black box” you will find that the customer dynamics of the competence bloc has little to do with Keynesian demand. The actors of the competence bloc contribute (commercial) competence in the technological choice process. This argument also serves as a rationale for competent purchasing and acquisitions, including public competent purchasing in areas where goods and services are supplied by public authorities.

Second, basic technology is internationally available, but the capacity to receive it and make a business of it requires local competence. Part of this receiver competence (Eliasson 1987a and b, 1990a, and 1996, pp. 8 and 14) is the ability to create new winning combinations of old and new technologies (*innovation*). As we know (see e.g. Larsson, Lembre and Mehldal 1998) a rich and varied supply of subcontractor (technology) services is part and parcel of the innovation process.

Third, the task of the *entrepreneur* is to identify commercial winners among the suppliers of innovations and to get his/her choice of technology (*technology choice*) on a commercial footing.

The entrepreneur, however, rarely has resources of his own to move the project forward. He, therefore, (*fourth*) needs funding from a *competent venture capitalist*, i.e. a provider of risk capital, capable of understanding innovators of radically new technology and able to identify business needs and provide context. The money is the least important thing. *What matters* (Eliasson and Eliasson 1996, Eliasson 1997b) *is the competence to understand and identify winners and, hence, provide reasonably priced equity funding*.[7] The supply of such competent venture capital is extremely scarce. It is the critical part of the overall selection process and, if lacking in performance, is liable to result in the ”loss of winners”. In fact, *completeness* is a necessary condition for a functioning competence bloc. Making the competence bloc complete must, therefore, be the prime task of industrial policy (Eliasson 2000a). None of the ”pillars” (the actors) of the competence bloc can be missing, or the whole incentive structure will fail to develop (G. Eliasson and Å. Eliasson 1996, Eliasson 1998c). The venture capitalist and his escape *(exit*) *market (fifth)* are the most important incentive supporting actors. With no understanding venture capitalists the price of new capital will be prohibitively high or not available, and winners will be filtered away. With badly functioning exit markets the incentives for venture capitalists will be small and, hence, also for the entrepreneurs and the innovators. *Completeness* of the competence bloc is, therefore, a necessary requirement for the viable incentive structure that guarantees increasing returns to continued search for winners, i.e. for new industry formation. The venture capital market in Sweden is generally lacking in the industrial competence needed to fund radically new industry (Eliasson 1997b), and even though the exit market situation has been improving, compared to the US, Sweden is still an underdeveloped economy on both counts. It is, hence, very risky to be an innovator and entrepreneur in Sweden, since when the two have exhausted their own resources, there will be no one to turn to except unperceptive bankers, big company executives or public sources, all more or less incompetent in dealing with radically new industrial ventures. The risk is high that winners will get lost.

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[7] The venture capitalists also contribute managerial, financing and marketing competence through their network, but this comes later.

Finally and *sixth*, when the selection process has run its course and a winner has been selected a new type of industrial competence is needed to take the innovation to industrial scale production and distribution. We cannot tell in advance what the formal role of the industrialist is (CEO, chairman of the Board, an active owner etc.). He or she figures in the competence bloc on account if his or her capacity to contribute functional competence. The innovative selection dynamics of the competence bloc is what endogenizes and moves economic growth in the EOE.

It is true that Sweden features an extreme concentration of large-scale business leadership competence (Eliasson 1990b), but this competence has been acquired in traditional mature industries that innovate slowly. The management of innovation in the new type of industries like health care and biotech is radically different from that in mature industries like engineering. The general experience is that leadership competence acquired in traditional industries is of limited use in the radically new industry.

A viable competence bloc now has to exhibit two dominant properties:

(1) *Increasing returns to continued search* (R&D); if a potential winner enters the competition race, continued search (innovation experiments) will result in commercial success.

(2) *Sustained incentives*; the competence bloc has to be *complete* to support incentives for such sustained search (*completeness*).

As we have already noted completeness is a tough requirement. If one link in the experimental selection process of the competence bloc is missing or faulty (for instance because a competent venture capital industry does not exist) incentives will not be sufficient to stimulate the necessary innovative activity.

These systems properties will exhibit themselves when the competence bloc is complete and when sufficient critical mass has been reached. Then the competence bloc will function as an *attractor* such that new entry takes place in such a way

- that the competence bloc *benefits* from the new entrants, but also (because of competition) such

- that only new entrants that *contribute* to the competence bloc enter and/or survive..

The competence bloc then functions as a technological spillover generator and will begin to develop endogenously through its internal momentum (*critical mass*).

As a consequence of these synergies and the diversity (pluralism) of approaches and agent representation the allocation and use of the existing competence mass will be optimized and spillovers will characterize the developing competence bloc. These spillovers will diffuse along many ways and both further reinforce the internal development forces of the bloc and contribute serendipitously to other related and unrelated industries (Eliasson 1997a).

6. Technological diffusion

The diffusion of new technology occurs along five distinct channels (Table 6); (1) when people with competence move over the labor market, (2) through the establishment of new firms when people with competence leave established firms, (3) through mutual learning among subcontractors and the systems coordinator, (4) when a firm strategically acquires other firms to integrate their particular knowledge with its own competence base, (5) when competitors *imitate* the products of successful and leading firms (the ”*Japanese approach*”), and (6) through organic growth of, and learning in incumbent firms.

One important insight emerges from a close study of Table 6; efficient diffusion of new technology requires effective market support, notably in the labor market (item 1 in Table 6) but also in the venture capital market and the markets for mergers and acquisitions (M&A). Efficient diffusion is also a necessary condition for spillovers and competence bloc development, but it is not sufficient. For new technology to be introduced in production *receiver competence* (Eliasson 1987b, 1990a) is needed. Entrepreneurial and venture capital competence are part of this, but the general and rapid introduction of new technology also requires a varied and competent labor force at all levels (workers, engineers, managers and executive people).

When we integrate institutions, incentives and competition into one coherent theory we arrive at the full model of the experimentally organized economy (EOE), featuring growth through innovative competitive selection as in Table 3.[8]

Even though the new growth model is the most sophisticated one of the neoclassical macro growth models its growth trajectory is still tied to an exogenous moving force. We have demonstrated that micro-to-macro dynamics is not an orderly and predictable development. The theory of the EOE and that of the competence bloc departs from the new growth models in four significant ways; (1) the upper limits of long-term growth are set by the activities of innovators and entrepreneurs, (2) induced by economic incentives and pushed by competition, both factors being ultimately determined by the institutions of society, broadly defined and (3) limited in their performance by their competence to create and to introduce new ideas in production. The EOE finally (4) endogenizes the *time dimension* of the innovation, selection and growth processes. The next section demonstrates, using a model of the EOE that the institutions regulating incentives and competition, if differently fashioned, can generate enormous differences in long term macroeconomic growth, implying enormous social change. The final section discusses what this implies for policy making and the need for a viable social capital.

[8] As modeled in the Swedish micro-to-macro model MOSES (Eliasson 1977, 1991b). It is obvious that this is very different from the R&D macro production function approach to explaining innovative activity and ”endogenizing” economic growth in, for instance, Romer (1990).

7. The magnitudes involved; WAD versus the EOE

The EOE distinguishes itself from WAD theory because of the large dynamic systems effects that occur within firms (hierarchies) and between firms through reorganization (see Table 6). The few quantitative studies carried out show that very large systems effects are potentially achievable within the EOE that are excluded by assumption in the WAD model.

A system is composed of a value or output generating part and a superimposed information [computing/communication/coordinating] system. You may think of (see Eliasson 1990b, p. 57) a factory as being organized by two different information and communications systems; a fully automated and centrally controlled factory, or (alternatively) a completely decentralized system where each skilled worker links to the whole by reading and understanding the blueprints. The decentralized system may even be distributed (outsourced) over a system of subcontractors in the market. In that sense automating a factory means changing its information system. I have shown elsewhere that this information system does not come free of charge. It, in fact, draws considerable resources, more than 50 percent of the total in the average Swedish manufacturing firm (Eliasson 1990a), and resource use depends on the efficiency of this more or less distributed production organization. It also requires considerable top level competence to change the information system through reorganization (see Eliasson 1998b, 2000b) and such reorganizing often fails. The normal way to solve business problems, however, is through reorganization, i.e. through changing the ”coefficients” of the system and doing things very differently afterwards. In the WAD model this cannot be done. In terms of the EOE the outcome is close to unpredictable, except that the manager must have a fairly good idea about what he wants to achieve to succeed.

As a consequence it is very difficult to study or predict the consequences of organizational change analytically. And few studies have been attempted.

The predictions of the EOE, however, are that radical economic reorganization should be capable of producing very dramatic changes, and the more so the deeper the organization changes go. Generic technologies like the machine tools from the late 18th century, currently complex computer and communications technology, and perhaps in the future biotechnology, also cut deeper than more specific ones. Cutting deeper means making it very profitable to rearrange production flows significantly at the micro level, and this is what we implicitly associate with the Internet or the new economy. Table 7 illustrates in terms of the two ”boxes” mentioned above, using IT as an illustration. We first have rationalization measures (items 1 and 2). You can improve total systems performance by speeding up information flows, everything else the same. This was the popular view of IT for a long time. Engineers used CAD equipment as electronic drawing boards. The systems effects were negligible. You can also use the new information technology to speed up physical flows over a given structure. Robotics was the great issue in the early 1980s. Not even combining 1 and 2 (in Table 7) using impressive robots helped much.

The benefits started showing when information and physical flows were decoupled (items 3 and 4) and simultaneously reorganized which became possible with the new C&C technology. Doing only ”one” did not help much, but doing it simultaneously (item 5) produced dramatic effects, provided the organizational competence to do it right was in place.

The great industrial potential with the Internet (completely unforeseen some five years ago, see G. Eliasson and Ch. Eliasson 1996) economy appears to be associated with the deep simultaneous reorganization of both the information and the ”production” system (item 5 in Table 7). However, the competence requirements are extremely large and it is no wonder that the enormous investments in IT in the US during all of the 1990s took a long time in exhibiting themselves in the form of positive output effects (Rhodén 1999). Neoclassical macro growth theory explains little of this. Let me illustrate with a few empirical studies.

The *first* is about automation of an engineering factory (Eliasson 2000b) in which several similar production lines were operated parallel and only some were automated. The factory thus offered an interesting experimental situation. The local engineers decided to organize automation as they themselves saw fit, refusing advice from the parent company which had done the same thing in other factories. One production line was not planned to be automated (to begin with) and another, for specialized production was to be operated ”manually” as before. Without going into details, the two automation investments both failed. The details were not properly attended to in advance, and large costs for adjustment and correction of errors at the end of the production line were incurred.

The automated line, furthermore, lost in flexibility (set-up costs, and rigidity in general) what it gained in increased speed. In the end the manual production line for customized products exhibited as good productivity performance as the automated lines and at much lower capital costs. This outcome, of course, was neither planned nor necessary. The competence to organize automation right was lacking, and that competence included as well in this particular case, not to do it at all.

The *second* case is also defined at the firm level and concerns the introduction of an Internet type technology (EDI, see Eliasson 1998b) in a distribution network. The case is typical. The study was done at the Royal Institute of Technology (KTH) and the firm instructed the student to look only at item 1 in Table 7. One reason was that the company had recently made a huge investment in a centralized storage capacity. To do anything with EDI beyond item 1 would require that this storage investment be scrapped. We, nevertheless, studied the potential consequences of changes through the whole of Table 7. We found no significant pay offs for the EDI investments until after complete reorganization under item 5. Then the total effect was extremely large and most of it occurred through the removal of the central storage and the associated transactions costs. This study, however, raises the problem of what to mean by a firm in organization-based production studies like these. When the great benefits from reorganization under item 5 only occur if reorganization is taken beyond the limits of the firm, into a distributed (over the market) production system, we find ourselves in the midst of a dynamic version of Coasian analysis (Coase 1937). The notion of a firm is no longer clearly defined.

The *third* case covers the entire manufacturing industry and requires a dynamic micro-to-macro model simulation. Such a model exists in the form of the Swedish micro-to-macro model MOSES (Eliasson 1977, 1991b) that approximates the EOE. We have studied (Eliasson and Taymaz 2000) the very long-term macroeconomic consequences of a more or less flexible production organization and its response to external market change (market instability). Flexibility is defined in terms of the rate of entrepreneurial entry, the speed of exit of production units or flexibility of the labor market in terms of enforcing economically motivated reallocation of people. The way the micro-to-macro model is specified makes it reasonable to argue that this flexibility in turn depends on the institutions in the micro-to-macro model of the economy. We cannot claim, however, that the simulations represent what will happen in Sweden, but they tell very realistically the magnitudes involved. There are no particular benefits associated with increased flexibility in terms of exit and labor market mobility if the circumstances are such that they approximate a plannable WAD situation. On the contrary, these small inconsistencies and disturbances of minor significance may generate erratic and erroneous responses that destabilize parts of the micro-to-macro model of the economy. *The effects are very large but take a very long time coming.*

When external circumstances change flexibility becomes important. To generate the desired new production structure needed to cope with the change, new entry of firms is necessary but not sufficient. It has to be supported by sufficient exit of firms and a mobile labor force to make resources available. We have a clear case of Schumpeterian ”creative destruction” and an even more clear policy case; supporting the faster death of firms that do not cope. A comparison between US and Europe would be very illustrative here.

There is one additional highlight on EOE versus WAD economics. Long-term growth performance of the entire micro-to-macro model of the economy even improves (somewhat) in the simulation experiments if we change from a plannable WAD regime into an unstable market regime with entry only. There are two explanations. One is technical in the sense that the difference is small and may change sign after another decade of simulations. This is, however, an open question, since the micro-to-macro model of the economy with fully endogenized entry and exit has no prior built in mechanism that imposes asymptotic convergence. Simulation trajectories might very well continue “diverging for ever”. There is, however, also an interesting economic explanation. With optimally balanced flexibility in the production system an unstable market environment may in fact raise the opportunities in the economy compared to the predictable environment, if the actors (firms) are capable of exploiting them, and they are if the production system at large is sufficiently flexible. This exploitation of difficult and hidden opportunities predominantly takes place through new entry. This observation is consistent with Antonov and Trofimov (1993) who find, in experiments on the same model, that long-term performance increases (under an unstable market regime) when decisions are taken by actors individually, not being constrained by centrally imposed guidelines, in their case guidelines based on either Keynesian or neoclassical macro econometric model predictions.

The overall conclusion of the Eliasson and Taymaz (2000) and Antonov and Trofinov (1993) analyses is that *centrally imposed guidelines represent a reduced understanding of the economy* of (all) actors in the markets, or a misunderstanding of the economy compared to the completely decentralized and unregulated decision process where each actor bases its decision on its individual experience and individually conceived future. The optimal collective decision of society is then achieved through decentralized, individual and often inconsistent (”experimental”) decisions in the market, each being rational on the basis of its own particular information sets and logic.

Macro models are often designed to give policy advice to Government. They achieve clear recommendation by suppressing the role of firm dynamics in the growth process through prior design. This is one message of this paper. Besides not telling much about how growth occurs, neither do such models tell very much about the social consequences of growth, for instance associated with an unpredictable structural adjustment process.

8. Economic growth, unpredictable change and supporting social capital - the policy options

The implication of the experimentally organized economy is that constant and unpredictable change at the micro level is a necessary consequence of steady long-term growth. If society demands growth it has to accommodate the associated change socially and politically. The empirical evidence presented in the previous section suggests that this change is large in the long run and can be very dramatic also in the short and medium run, notably at local micro levels (Eliasson 1984). Hence, economic progress will subject both firms and human beings to significant, unpredictable and arbitrary change. The ability to cope with that change in a positive way will be a critical economic and social asset. There are also strong implications for industrial and labor market policy. They can be analyzed through the use of an appropriately defined concept of social capital. Jozef Ritzen (2001) suggests a narrow and operational definition of social capital that he calls social cohesion that represents the appropriate measure of belongingness for a group of people that we need for a meaningful policy analysis. Social cohesion contributes a private positive utility to its members. Social cohesion tends to be disrupted during periods of more than normal change in the EOE, implying a negative utility experience. This is an unavoidable experience by the individual now and then during a normal growth process. During periods of radical change, for instance during the early phases of the industrial revolution and, perhaps, also during a current possible transition to a new economy this change with negative utility experiences coupled with great opportunities are likely to be dramatic. It is, therefore, important to be capable of coping with change. And the social capital will have to be part of the support in that respect.

GNP growth is the output of such a process. GNP is not a good measure of well being for a population. It is rather a measure of the resource flow generated in the economy. Well-being is more a private experience based on the part of the resource flow that becomes available to the individual (Eliasson 1991a, pp. 129 ff; 1994b). To some great extent, then, the individual is privately responsible for his or her well being, notably through his or her earnings capacity, through arranging for insurance etc., but also through other personal attributes. So we should continue to be interested in macroeconomic growth as defined. How much responsibility should be taken by other people in the group held together by social capital or by Government is a matter of institutions in the form of conventions, morals and politics.

Lars Osberg and Andrew Sharpe (2001) want to correct the GNP measure to obtain a better measure of well-being. They correct the GNP measure for three factors; risk (insecurity), distribution and wealth accumulation. (The latter also, of course, has a distributional dimension). This is when problems begin to enter. The previous analysis has emphasized three supporting factors behind the welfare complex: (1) competence and *education*, (2) flexibility, allocation and the *labor market* and (3) unpredictable and arbitrary change and *insurance*.

Ideally change and risks should be coped with through insurance, and social insurance as well as regular private insurance developed to serve that purpose. A functioning labor market is also part of the insurance since it facilitates the search for a new job when you have lost one. Finally, however, competence and education run ”positively” through both the labor market and the insurance dimensions (Eliasson 1994a,b,c), and it is comforting to observe the strong support from that observation in Wolfe and Haveman (2001). Hence, key to the accumulation of both human and social capital appears to be a factor called ”education” broadly defined.

The distributional problem is more difficult to deal with. If your personal well-being (utility) depends on how large a part of the resource flow your neighbor can access relative to yourself we face an impossible catch 22 problem. Economics has very little to offer here, except referring problems of distribution and fairness to politicians, perhaps suggesting that if you want ”more fairness” than the market supplies, ”you” will have to pay in terms of less growth, everything else the same. Suppose everybody to feel well wants to keep the distance downward to his or her less endowed neighbor and catch up or pass in the other direction. Then we will have a crowd of constantly dissatisfied people, however fast everybody’s access to resources grows. The implication may be that total welfare diminishes because policies promote envy.

We have argued already that human and social capital definitions are purpose and allocation dependent. To arrive at an operationally meaningful definition of social capital in this context we want a measure that captures the belongingness discussed above. Such a measure carries positive personal utility and tends to support individual well-being during normal economic change. For our purposes this is enough, except that this measure only covers some of all the dimensions of social capital that have been discussed in the literature. There will be separable dimensions that can be added simply, and there may be integrated dimensions that will be more difficult to deal with analytically.

Already here certain policy conclusions can, however, be drawn. Well-being can be enhanced for each given income stream by (social) insurance. Insurance is also provided through the labor market, partly in the form of job security, partly (and running counter to job security) through easy access to jobs. Another dimension of insurance or personal capacity to cope with almost everything that concerns us is the factor education (see Wolfe and Haveman 2001). Educated people tend to have better access to jobs, be more capable of coping with change, be healthier, etc. than less educated people (Wolfe and Haveman 2001, and several other papers). In some ways, apparently, education proxies for the narrowly defined social capital we have discussed, suggesting, on this score, that the policy problem associated with the quality and availability of social capital first becomes focused on three areas; education, the labor market and (social) insurance. Here, however, we have a paradoxical problem. These three areas are conventionally public responsibilities. They became public policy precincts because the market failed to come up with acceptable solutions. And now we face public failure in these areas of (nowadays) public monopoly. Will politicians be up to this challenging task?

Table 1. The axioms of the EOE models

1. State space; enormous and extremely varied

2. Behavior characteristics

   - bounded rationality
   - tacit knowledge
   - intuition

3. Institutions regulating entry into state space.

Source: Eliasson (1996, p. 24).

Table 2. Competence specification of the experimentally organized firm

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: Eliasson (1996), p. 56.

Table 3. The four mechanisms of economic growth

1.Entry

2.Reorganization

3.Rationalization

4.Exit (shut down)

Source: Eliasson, G. (1993) “Företagens, Institutionernas Och Marknadernas Roll I Sveriges Ekonomiska Kris (The Role of the Firms, Institutions and Markets in the Swedish Economic Crisis)” Appendix 6 in ed. A. Lindbeck *Nya Villkor För Ekonomi Och Politik* (New Conditions for Economic Policy) SOU 1993:16, pp. 195-233; and G. Eliasson (1996, p. 45).

Table 4. Actors in the competence bloc

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, 1996 "The Biotechnological Competence Bloc" *Revue d'Economie Industrielle,* 78, 4^0 Trimestre.

Table 5. The dominant selection problem

Error Type I: Losers kept too long

Error Type II: Winners rejected

Source: G. Eliasson and Å. Eliasson, 1996 "The Biotechnological Competence Bloc" *Revue d'Economie Industrielle,* 78, 4^0 Trimestre.

Table 6. New Technology is diffused

1. When people with competence move (labor market)
2. Through new establishment by people who leave

Other firms (innovation and entrepreneurship)

3. When subcontractors learn and vice versa
   (competent purchasing)
4. Technology is acquired through strategic acquisitions of small R&D intensive firms (*strategic* acquisitions)
5. When competitors learn from technological leaders (imitation)
6. Through organic growth and learning in incumbent firms.

Source: G. Eliasson, 1995 *Teknologigenerator Eller Nationellt Prestigeprojekt? Exemplet Svensk Flygindustry* (A Technology Generator or a National Prestige Project? The Swedish Aircraft Industry). (Stockholm: City University Press).

Table 7. Systems effect categories at different levels of aggregation in Knowledge Based Information Economy

1.	Speed up info flows	over given structures (*rationalization*)
2.	Speed up physical flows	over given structures (*rationalization*)
3.	Reorganize info flows	
4.	Reorganize physical flows	
5.	Do all simultaneously	(*integrated production*)

Source: Eliasson, G., 1998c "Information Efficiency, Production Organization and Systems Productivity - Quantifying the Effects of EDI Investments" in eds. Macdonald, Madden and Salama *Telecommunications and Socio-Economic Development (*Amsterdam: North-Holland).

Figure 1. Swedish manufacturing production 1546-1998

(to be supplied separately)

Source: Eliasson 1988 "Innovation, Market Structure and the Stability of Industrial Development" in ed. Hanusch *Evolutionary Economics* (Cambridge: Cambridge University Press): 158, and updates.

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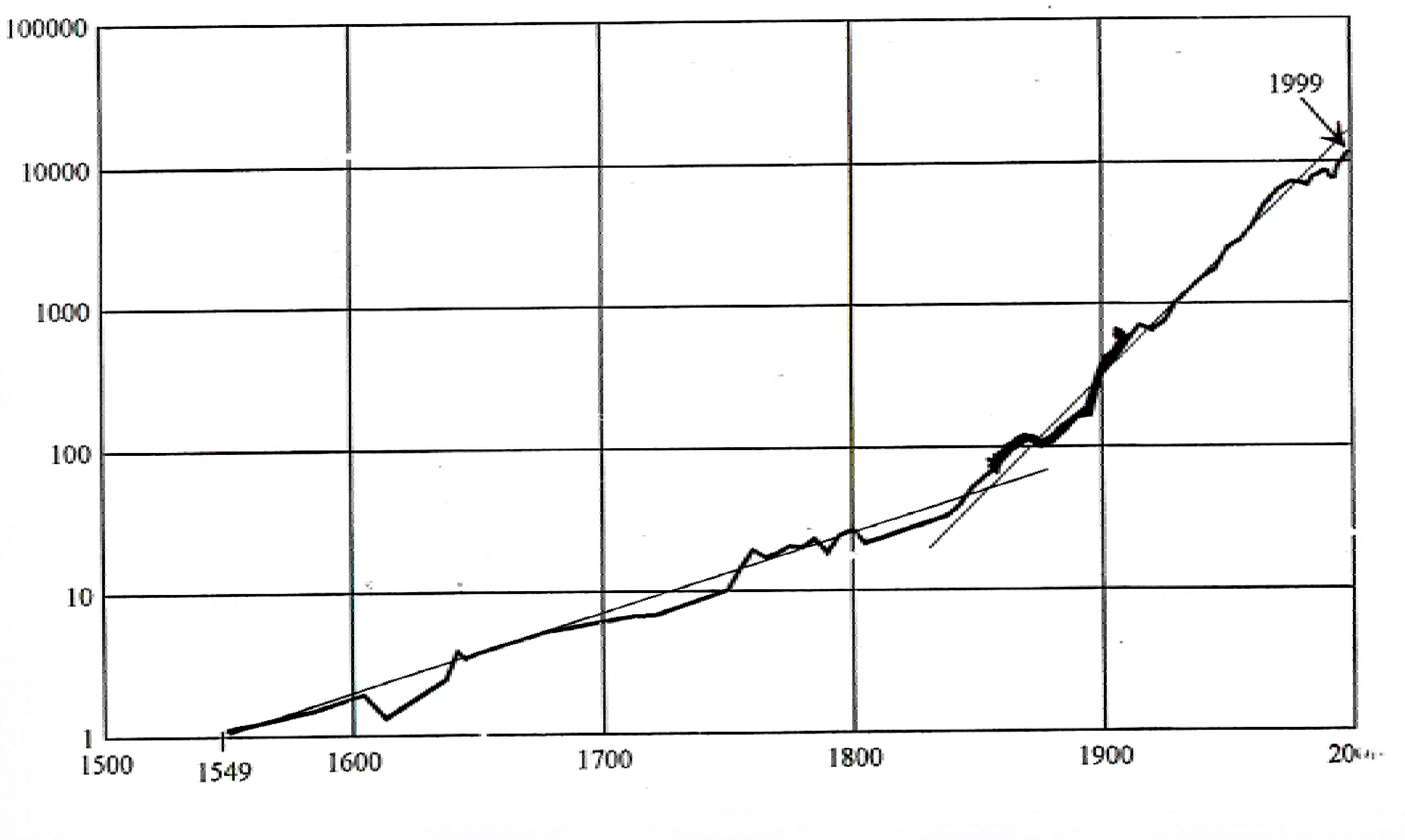
Figure 1. Swedish manufacturing production 1549-1998
Index 1875 = 100



Source: Eliasson, G. (1988) "Innovation, Market Structure and the Stability of Industrial Development" in ed. H. Hanusch *Evolutionary Economics* (Cambridge: Cambridge University Press): 158 and updates.