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Firm Tunrover and the Rate of Macroeconomic Growth – Simulating the Macroeconomic Effects of Schumpeterian Creative Destruction

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FIRM TURNOVER AND THE RATE OF MACRO ECONOMIC GROWTH

- simulating the macroeconomic effects of Schumpeterian creative destruction

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Abstract

The positive effects of new innovative entry and fast and efficient allocation of resources are balanced against the efficiency of price signaling in markets in a non-linear micro based simulation model of an Experimentally Organized Economy (EOE). In this model increasingly rapid reallocation of resources over markets, moved by innovative new entry and competitive exit (the rate of firm turnover) generates faster growth in output, but eventually, if too fast, is shown to affect the reliability of price signaling in markets and to raise the frequency of investment mistakes. Beyond a certain level of the rate of firm turnover the aggregate effects at the macro level, therefore, turn negative. This optimal growth trajectory depends on the balance between the rates of entry and exit and on the performance of new firms compared to incumbents, their size compared to incumbents and the variation in the same characteristics.

Key words: Business Mistakes, Economic Systems Stability, Endogenous Growth, Experimentally Organized Economy (EOE), Firm Turnover
JEL Code: C15, C45, C62, C81, L16, O12.

1. The dynamics of resource allocation in an experimentally organized Economy

The experimentally organized economy (Eliasson 1987, 1991a, 1996) is characterized by an extremely large and heterogeneous state space (investment opportunities set) into which boundedly rational agents (firms) guided by tacit knowledge search for opportunities. This search is also an act of learning and creative discovery such that new opportunities are created and the opportunity set expands as it is being explored. The paradoxical result emerges that "we" may become increasingly ignorant about all that can be learned about (the Särimner effect, Eliasson 1987, 1990b. pp 46f, 1996 p. 27f). Hence, the economy behaves at each point in time as for all practical purposes an open ended system. Growth is highly non-linear in new technological discovery and occurs through experimental selection through the entry of new firms, forcing reorganization and rationalization or exit on incumbent firms. We call this *Schumpeterian* C*reative* D*estruction* (Table 1) and propose the existence of an initially positive relationship between the rate of firm turnover (the number of entries and exits in relation to the total number of firms), that may, above some fast and unbalanced rate disturb price signaling in markets and turn negative. The internal conflict between stabilizing and equilibrating properties works itself through the economic system (Eliasson 1983,1984). Such phenomena go theoretically undiscovered in the mainstream neoclassical model. They may involve such extreme disturbances that never, or rarely, occur in reality, or involve such long-term non-linear relationships that they will not be possible to capture econometrically. To establish the possible theoretical existence of such a long-term downside of Schumpeterian creative destruction only simulation analysis will do.

Schumpeterian Creative Destruction

We study the macroeconomic effects of firm turnover in this Schumpeterian creative destruction process (Table 1) in which macroeconomic growth is moved by experimental selection. We use a model version of the EOE, the Swedish micro-to-macro model called MOSES. For our purposes this model economy has two fundamental properties.

(1) With a huge and complex state space the opportunities for very large systems productivity effects through dynamic reallocation of resources are significant. Much of that reorganization occurs through the entry and exit of firms (Eliasson 1991a,b, Johansson 2001, Eliasson – Taymaz 2000).

(2) The faster resources are being reallocated through entry and exit, other forms of organizational change, however, the faster structural change in the economy and the more unreliable price signaling in markets, causing in turn an increase in costly mistaken business decisions with a small learning content, and a negative effect on growth (Eliasson 1983, 1984, 1991a). Hence, there are *increasing negative returns to increased searc*h ("learning") of state space (the investment opportunity set; Eliasson 1990a) as agents attempt to probe state space faster in the short-run to reach even higher economic systems productivity levels (Eliasson 1989, 2001). These negative returns to too fast learning occur because the coordination mechanism of the model economy (price signaling in markets) is disturbed, price signals becoming increasingly unreliable and causing an increased rate of

mistaken decisions. The main purpose of this paper is to demonstrate the existence of this effect.[1]

Starting from zero entry of firms and increasing it we would, hence, expect an increasingly positive outcome to begin with, which will eventually begin to decline. When almost all firms are changed through entry and exit each period output might even be smaller than in the no turnover case. Somewhere in between there is a maximum. In the short run the hypothesis of positive effects of firm gross turnover can be tested econometrically. Johansson (2001) has also found econometric support for a positive linear relationship. The long-run curvature hypothesis, however, is not tractable by econometric analysis and for two reasons. *First*, time series data of sufficient length to reveal the non-linear property are simply not available. *Second*, the time span we now consider will include so many interactive influences that the model needed to capture them and keep them apart will probably be beyond econometric analysis. It may be the case that the negative influences begin to show so early that agents, including policy makers, begin to react to counter these effects. If so, this analysis becomes a pure theoretical inquiry into the possible existence of such a negative effect in a controlled experiment. In such a controlled experiment (Eliasson 1991a, Eliasson-Johansson-Taymaz 2004), we expect a situation of chaotic behavior to emerge. Under normal circumstances agents make mistakes and respond to mistakes and the economic system at large is self-regulating. Above a certain rate of turnover, however, this self-regulation begins to malfunction and a slow destabilizing momentum begins to cumulate. At the macro level of forecasters the economic system, however, sends no alarm signals until a strong surge of negative macroeconomic influences begins to show.

This long-run dynamic property of the EOE becomes analytically tractable in the model approximation of the EOE, i.e. in MOSES. Macroeconomic change in the MOSES model economy occurs through the Schumpeterian creative destruction process of Table 1. For this to be a positive growth experience, however, there has to be a balance in firm turnover between entry (item 1) and exit (item 4). In reality this probably means that innovative entry initiates competition that forces incumbent firms to reorganize their business and failing firms to exit and that the exit process is not curbed by industrial policy but rather facilitated (Eliasson 2000, Eliasson-Taymaz 2000). We would, hence, expect a non-linear relation between the rate of firm turnover and long-run economic growth under certain, perhaps quite general circumstances. For low rates of turnover and short periods the relationship should appear positive and approximately linear as demonstrated in econometric tests (Johansson 2001). The same relation should, however, be non-linear over the longer term, eventually to turn negative.

This hypothesized non-linear relationship has been econometrically tested on data generated by repeated simulation experiments on the MOSES micro-to-macro model of the Swedish economy. Incentives for entrepreneurial entry have been gradually raised and the simulated long-run effects on total output recorded. The hypothesis is that the disturbed price signaling in markets increases with the rate of turnover and structural change and that the effects on total output changes from a positive to a negative one somewhere in between

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[1] A brief presentation of the micro-to-macro model tailored for our particular experiments is found in Eliasson – Taymaz (2000) and Eliasson-Johansson-Taymaz (2004). A more principal presentation is found in Eliasson (1977, 1978a, 1991a and 1992,) .The macro economic effects of disturbed price signaling in markets due to inflation were studied in (Eliasson 1978b). In addition there are five MOSES books, (1) *The Firm and Financial Markets in the Swedish Micro-to-macro Model* (Eliasson 1985), (2) *MOSES Handbook* (Bergholm 1989), (3) *MOSES Code* (Albrecht et al. 1989, (4) *MOSES on PC – Manual, Initialization and Calibration* (Taymaz 1991) and (5) *MOSES Database* (Albrecht et al. 1992); all five published by IUI, Stockholm.

no entry and a complete turnover of all firms each period[2]. We also hypothesize that the negative influence on long-run growth will occur faster, (1) the faster firm turnover and (2) the more unbalanced the entry and exit process.

To carry out these experiments we have used the latest version of the MOSES model of the EOE with endogenous R&D generation of innovations and genetic learning of firms from one another (Ballot – Taymaz 1998, 1999). This model has been calibrated against historical long-term development of the Swedish economy using an early method of structural estimation developed as part of the micro–to–macro modeling project (Taymaz 1991, chapter 3).[3]

On non-duality and unreliable price signaling

The experiments we are considering can only be performed on a model economy that is operationally defined outside static equilibrium and that has no exogenous equilibrium as conventionally defined. Its equilibrium properties have to be defined differently and should rather be discussed in terms of economic systems stability (Eliasson 1983, 1984). In static equilibrium duality prevails. Prices map exactly into quantities and quantities map exactly into prices. Non-duality can only be analyzed on the static general equilibrium model for infinitesimal departures from that same equilibrium to which the system always returns (converges) i.e., to the original (same) equilibrium, or almost there ("practical stability", La Salle – Lefschetz 1961). This rubber-band fixed-point based equilibrium analysis does not recognize time and the possibility that the system, because of its departure from static equilibrium may go "elsewhere".[4] This non-convergence property is, however, to be expected in an economy where information use and communications activities dominate resource use and where technological change in computing and communications (C&C) technology dominates total productivity change through constant systems reorganization (Eliasson 1990b). Hence, to analyze the systems instabilities generated by endogenously disturbed price signaling in markets that removes price taking behavior of individual agents from the model we need a " different" non-linear micro-to-macro model such as MOSES. We argue this point by way of a critical survey of neoclassical exogenous equilibrium growth models that claim to capture real life creative destruction and the role of firm dynamics in economic growth.

When entrants are characterized by very large diversity of performance, and are not necessarily better than incumbents on the average new (and young) firms tend to perish at

[2] Cf. Eliasson (1978b) where the macro economic growth process is fairly unaffected by such disturbances caused by inflation up to a certain level, then to turn negative.

[3] Complex economic models involve a number of unobservable parameters. These parameters are either estimated statistically from reduced form models, or, in most of the cases, substituted by researchers' best "educated guests". The way the parameter values are set has been one of the main reasons why these models has been ignored and even disregarded as a robust analytical tool by orthodox economists. However, we have developed a calibration algorithm to set parameter values for the MOSES model at the early stages of model development (Taymaz 1991b). This calibration or structural estimation program, based on a random hill climbing algorithm, fits the "model" to a number of sectoral variables, but it can also use micro-variables for calibrating parameter values. As shown by Balistreri and Hillberry (2004), estimation and calibration exercises are identical under consistent identifying assumptions. Both methods fit a model to data. Therefore, one should not consider econometric models as a superior analytical tool. In terms of fitting the data, there is no difference between econometric models and simulation models. However, simulation models allow the researcher to model underlying interaction mechanisms and, hence, a robust analysis.

[4] For a discussion of this "chaotic property" see Eliasson (1983, pp. 274 ff).

a higher rate than older incumbents. This property of the model is compatible with evidence reported in literature and in Johansson (2001).

When entrants are very much better and very large and variance in performance low, the incumbent firms will soon perish and only the new and superior firms remain. Such a structure is vulnerable to unexpected change. It leaves a permanent change in the economy (non reversibility) and easily turns fast growth into low growth (Eliasson 1983, 1984). This phenomenon, however, can only be "observed" through model simulations.

In fact, earlier model experiments have uncovered a conflict between static and dynamic efficiency in the sense that considerable diversity of characteristics at the firm level are a necessary requirement for stable and sustained macro economic growth. This does not only mean (Eliasson 1984, pp. 263 ff) diversity in the sense of different, but also diversity in the sense of more or less efficient firms (the existence of slack) and constant change at the micro firm level. Steady state like macroeconomic growth thus has to be supported by constant and "substantial Brownian motion at lower levels" (Eliasson 1984, op. cit., p. 266), and vice versa: If that micro economic dynamics is blocked, e.g. exit prevented by policy, negative long-run macro economic effects will eventually begin to show. This is part of the phenomenon we study in this paper that is difficult and probably impossible to demonstrate by traditional econometric methods.

Testing for the presence of the long-term negative influence we proceed in two steps. We survey the empirical literature on firm turnover to make sure that the input into the simulation model and its intermediary output is compatible with observed " stylized facts" (next section). We then clarify the reasons for our departure from the neoclassical equilibrium " growth model" through a critical survey of that literature. We then go on to present the alternative model of the Experimentally Organized Economy in which business mistakes become part of transactions costs and use it to establish the existence of a negative long-term relationship between the rate of (and balance of) firm turnover and macroeconomic growth through simulation experiments.

2. Stylized facts about firm turnover

Entry, and even more so exit, for long was an avoided problem in economic theory, because of the mathematical difficulties of allowing for the phenomenon in neoclassical exogenous equilibrium models. As an empirical phenomenon it, however, unmistakenly exists, and some early, empirically oriented economists (Orr 1974, du Rietz 1975, 1980, Hause-du Rietz 1984, Highfield-Smiley, 1987, Baldwin – Gorecki 1987, 1989, 1990, Acs – Audretsch 1989) defied the theoretical problems and launched the needed empirical inquiries that made it possible to learn about the magnitudes involved in the firm turnover process. The econometric models estimated, however, are often only loosely related to mainstream economics, and normally conflict with the exogenous equilibrium properties of the Walras-Arrow-Debreu model[5]. For this reason the interest among economists in

[5] For a long time, and perhaps still, it was an almost mandatory part of an economics dissertation in Sweden to prove (not only discuss) the existence of an exogenous equilibrium in the model used for econometric or theoretical analysis. This is, of course, a horrendous task if the appropriate model does not, and should not have that property as conventionally defined. Not every doctorate candidate is capable of coming up with such clever mathematical tricks as Dasgupta-Stiglitz (1981) and this enforced task unduly and completely unnecessarily delayed the completion and publishing of du Rietz' (1980) dissertation, a true empirical inquiry

entrepreneurship and new firm formation has not been overwhelming. Modigliani's (1958) review article on new oligopoly theory declared that monopoly power was determined by the minimum size of the maximum effective plant. New entry as a competitive price setting factor was not even considered important. In passing that article, therefore, killed interest in new entry for years. For a long time conventional wisdom was (see e.g. Eriksson 1984, p.52) that " industry growth comes mainly from existing firms". This observed (Eliasson 1991b) is either a trivial conclusion or a reflection of the short-term nature of economic analysis. In simulation analyses Eliasson demonstrated that entry and exit may not affect macro variables much in the short- term. Under reasonable assumptions, however, they mattered significantly in the long- run. That it took a long time for any significant effects of new entry to appear at the macro level had been demonstrated already by du Rietz (1975, p. 17 and 20). Johansson (2001), furthermore, showed that new and small firms stood for all growth in employment in the Swedish IT industry between 1993 and 1998 while the large firms as a group significantly reduced their employment. To capture the long- term effects, however, simulation analysis is necessary.

According to the neoclassical I/O story profitability in excess of equilibrium profitability induces entry. Hence, " entry became seen as one of the main mechanisms by which long-run equilibrium" is restored (Audretsch- Mata 1995), a story that is also part of Kirzner's (1973) Schumpeterian type model. They are all conservative stories and consistent with the notion of an external equilibrium, and, hence, of little interest as a factor behind economic growth. Research on new entry and later firm exit was, however, stimulated and can be divided into two fields of inquiry; emergence, mostly an interest of non-economists and the firm entry, survival and later death cycle.

Apparently the story of firm turnover and growth is a complicated one. We have to decide what to mean by entry and exit, which theoretical model to fit to, and help interpret the data reliably, and then how to bring it all together into a consistent story. We begin with the facts.

Determinants of Entry - the emergence process

While economists still have serious problems with fitting entrepreneurship into the standard growth model, a large group of non-economists have no such problem. They study the emergence of entrepreneurs and business births (and deaths) without bothering with such things as equilibrium prices and profits, but rather draw heavily on psychology, sociology, philosophy, and economic history (Gartner 1985, Katz-Gartner 1988). None of the members of the two schools of literature are happy to quote members of the other group, and this may partly, but only partly be explained by the lack of overlapping " theoretical " frameworks and difficulties to communicate. There are, however, exceptions; William Baumol coming in from pure economic theory (e.g. 1968, 1982, also see Eliasson-Henrekson 2004) who early and since then consistently have attempted to integrate entrepreneurship and entry in the mainstream economic model; Israel Kirzner, with roots in Austrian-Mengerian economics (e.g. 1973, 1978, 1989). Paul Reynolds, with an equally pure empirical background in sociology (Reynolds 1991, 2004, Reynolds-Storey-Westhead

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into the entry and exit processes in Swedish manufacturing, based on a unique empirical material. Also see du Rietz (1975), Englund (1980) and Hause- du Rietz (1984).

1994, Reynolds-Miller-Maki 1995) has been attempting for years to bring the sociological dimension into the economics of growth.[6]

David Birch (1979, 1981), however, appears to have been the first to focus research attention on the importance of new and small firms as contributors to industry growth. Zoltan Acs and David Audretsch have been striving since the mid 1980s to make economists pay attention to firm entry. A number of researchers then carried on to demonstrate that small firms create a disproportionably large share of new jobs (e.g. Davidsson-Lindmark-Olofsson 1994. Kirchhoff 1994, Johansson 2001). Davidsson-Henrekson (2001) emphasized that the rate of new firm formation was a distinguishing feature of growing and stagnating economies and that the low rate of new firm establishment in Sweden was the most probable reason for the bad growth performance of the Swedish economy a conclusion IUI had already arrived at in 1993 in its *Long Road* to Recovery (Andersson et al 1993)

Survival and Exit

Baldwin-Rafiquzzaman (1995) study the relationship the quality of the initial entry selection and the later survival performance of the entry cohort. Three results stand out; *First*, the higher the entry rate the lower apparently the " average" quality and the lower survival rates. *Second*, however, the higher the entry rate the higher the quality of the survivors and the faster the growth rate of survivors during the first ten years, as is also the growth rate of the entry cohort as a whole. *Third*, while the entry rate depends positively on the cost advantage of entrants over incumbents the more they are forced to learn the faster survivors grow.[7] Here Mata-Portugal-Guimares (1995), however, find that new plants are likely to survive longer if they have entered a growing industry or market with a lower entry activity, read with less competition. It is, however, important to keep the different partial hypotheses apart in a model to interpret the empirical results properly. In Brito-Mello (1995) a theoretical model is developed in which the information banks have on borrowing firms determine the terms on which they obtain credit. As banks learn about the firms, credit terms are also assumed to be eased. Banks furthermore are assumed to learn as the firm ages and grows. Hence, obviously for surviving firms the older and larger they are the faster they grow because of a better access to external finance on advantageous terms, everything else the same.

It is still interesting to contrast these highly partial and theoretical results with the rough empirical results reported by Doms-Dunne- Roberts (1995). They find that the more capital-intensive and the more intensive in their use of advanced technology plants the faster growth and the less likely firms are to fail. These results are, however, very sensitive to the influence of size on growth, and only come out clearly if size is controlled for. When not controlled for the influence on growth is negative and tends to wash out the positive effects of technology. The real problem, however, appears when we try to digest the Doms et al (1995) and Brito-Mello (1995) articles simultaneously. First, a version of the Brito-

[6] We recognize this as an ambition that should be encouraged in each specialized field and observe that this was a main reason why Baumol and Reynolds two were awarded the International Prize in Entrepreneurship and Small Business Research by Swedish FSF and Nutek in 2003 and 2004 respectively. David Birch and Zoltan Acs and David Audretsch had received the same price already in 1996 and 2001, respectively.

[7] The question is whether this should be called learning. During the first year of life of a new firm fixed installation costs should dominate the cost structure and wages exceed labor productivity. We then rather have a case of excess capacity. As the new firm gets going that excess capacity should disappear and the true productivity potential of the new firm be revealed.

Mello model could have been fitted to the Doms et al data set and the empirical results would neither have been the predicted ones nor been interpreted the same way. Second, both models neglect a possible selection problem, namely that the Doms et al results may reflect a positive selection of technologically advanced firms that show superior growth performance irrespective of size. Once that selection has been made the Brito-Mello partial effects may click in empirically even though the Doms et al and Baldwin-Rafiqussaman results do not suggest that they will show up.

On this, and to their surprise, Boeri-Bellmann (1995) find that exits do not increase in the cleansing destruction phase of the business cycle. While new firms tend to shut down when in cyclical trouble old firms rather contract, and the older firms get the more their performance follow business fluctuations. Hence, as the cohort grows older the exit rate in the business down swing decreases and the cohort firms increasingly swing with the cycle.

On this Audretsch (1995) concludes that what happens after entry (post-entry) " is at least as important as the entry itself". Audretsch asks if entry as a growth contributing factor may be less interesting as entry as a disequilibrating factor changes the structure characteristics of production and the market. The question, however, is whether this is an interesting distinction to make in this context. Audretsch (2002) himself, Johansson (2001) and others have shown that much of growth of an industry can be directly attributed to new and small firms, but this, of course, is post-entry growth in those firms. In the longer run, as the surviving, once new firms prosper and grow while incumbents stagnate or disappear the once new firms will increasingly dominate both industry output and industry performance characteristics (Eliasson 1991b). Most of this influence, however, comes by way of the market disequilibrating influence of entering and growing firms, i.e. through competition through lower prices and better products.[8]

Old and large firms die more slowly than new and small firms.[9] This conventional understanding has survived for decades. Even though the death rate of old firms seems to be on the increase (Pratten 2004, Chapter 2 in this volume) the fates of new firms are particularly interesting from the point of view of understanding the nature of the EOE. New and small firms have smaller financial resources to burn to sustain a winning business experiment and (perhaps) less experience than the big firms, and the time dimension of the

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[8] The important role of new competition through new entry was apparent in the early simulation experiments on the MOSES model (Eliasson 1978a,pp 52ff) even though nobody found that interesting at the time.

[9] See for instance Audretsch-Mahmood 1994,1995.

In the MOSES model of an EOE to be used below new entry is a random drawing from a distribution of firm performance characteristics which show a much broader spread in productivities, but a lower average than the corresponding distribution for incumbent firms (Granstrand 1986, Eliasson 1991b). This highlights the boundedly rational character of new entrants and the experimental nature of new entry, optimistic entrepreneurs who don't know their capacity to perform compared to incumbent firms happily entering the market at great risks many of them facing immediate failure. Some of them are, however, winners and if they enter in sufficient number and if the environment in which they enter is sufficiently favorable to entrepreneurship they will eventually begin to make their marks on macro economic growth, as is demonstrated in Eliasson (1991b).

These simulation results are compatible with the theoretical predictions of Jovanovic (1982), however, for very different reasons (See section 3 below). Andersson-Vejsin (2000) offer an alternative and what they consider neglected hypothesis, what they call the Solow vintage hypothesis, that recognizes the possibility of updating incumbent technologies rather than shutting down the plant. They also find econometric support for the hypothesis that the probability of plant failure increases with the age of the technology vintage and that plants that use high-quality human capital are more likely to exit than others.

birth, life and death cycle of a winning project appears to be much longer than the life cycle of the innovating, new firm. The risks are high for innovators, especially if they try their luck in bad entrepreneurial environments (See competence bloc analysis in Chapter X). Here Dunne-Roberts-Samuelson (1988) concluded that the characteristics of a firm at the time of entry still influenced the success of the business some 10 or 15 years after entry.

Dunne-Klimek-Roberts (2003) conclude that "history plays an important independent role in conditioning the likelihood of survival". Above all, they continue, the exit decision is not only conditioned by current and future "plant, firm, and market conditions". Experienced plants that enter by diversifying their product mix have the highest exit rates in the sense of exiting a market, not necessarily closing a plant, followed by new, inexperienced entrants, and then new plants owned by inexperienced firms. The probability of manufacturing plant deaths (shut downs) appear to be higher in labor intensive production subjected to low-wage competition from abroad. Such shut downs occur more often, continue Bernard-Jensen (2002) at plants with a multi-plant firm and at plants recently subjected to change in ownership. Furthermore, plants "owned by U.S. multinationals are more likely to close" than other similar firms. This suggests, as we have argued (above and in Eliasson-Eliasson 2004) that reorganization, including shut-down is a management instrument.

On the whole, in a historic perspective, and this takes us closer to our ultimate ambition to relate firm turnover to growth business shakeouts involving massive plant closures are part and parcel of the normal creation and establishment of an industry (Klepper-Miller 1995).

Environment and New Firm formation

Highfield-Smiley (1987) in their early study on the importance of environmental factors in new firm formation conclude surprisingly that individuals decide to found new firms when economic conditions, such as GNP growth, are sluggish and unemployment high, but that those who enter go for dynamic, technically progressive and profitable industries.

There is also an entirely different and more eclectic institutional literature on long-term economic growth, beginning with North-Thomas (1970,1973) who argue that new firm formation and economic growth (The Industrial Revolution) came with the establishment of a functioning property rights system. More recently de Soto (1989, 2000) predicted the hopeless economic future of the non-western, notably socialist societies that have not got the institutions needed to turn assets into productive capital in order, notably the property rights. One instance of this is the common regulation of firm entry and prevention of exit in poor countries. Such regulation holds back competition, benefits incumbent failing firms, politicians and bureaucrats, promotes corruption and devastates the economy (Djankov, LaPorta, Lopez-de-Silanes-Shleifer 2000). On this Posner (1975) argues that competition in the US to obtain a monopoly position means a transformation of expected monopoly profits into social costs. However, Posner argues, " public regulation is probably a larger source of (such) social costs than private monopoly". A particularly devastating such regulation is the legal provision of possibilities for interested parties to prevent the exit of firms that have no economic value. Carlsson (1983) have computed the enormous social costs associated with preventing the bankrupt Swedish shipyard industry from being effectively shut down. Eliasson-Lindberg (1981) also show that the large cost is not the originally sunk investment but the opportunity cost of operating the failed plant, depriving the market of a labor supply and driving up wages, thereby reducing growth elsewhere. On this Lim-Hahn (2003) demonstrate the beneficial economic effects of the South Korean bankruptcy reform 1998 that removed the possibilities for interested parties , including labor unions and owners to prevent the closing of large failed firms.

To conclude, the stylized facts are that rates of entry and exit develop parallel but vary between economies (Geroski 1995, Siegfried – Evans, 1994, Caves 1998). Furthermore, there is econometric evidence of rates of entry being dependent on rates of return in the firm and/or in the market entered but the evidence varies between studies. The reason for the absence of such relationships in some studies might be that entrants are generally overoptimistic and believe their technology to be superior to that of their incumbent competitors in the market and be independent of the situation at large in the market. In reality then, entry depends on expected profitability on the part of the entrant, which is difficult to measure. Highfield-Smiley (1987), however, believe that the lack of empirical support of this relationship in other studies (for instance in the much quoted early Orr 1974) depends on a " lack of sophistication in modeling entrepreneurs´ expectations about future profit rates". It is also hard to believe that there should be no relationship between the aggregate profitability situation in a market and the rate of entry in the same market. Most probably this is where one should begin to look for the absence of an econometric relationship. Stylized facts, in fact, are that entry increases and exit decreases with profitability and growth in the local markets (Siegfried – Evans 1994)[10].

Another stylized fact is that the average performance of entrants is lower than that of incumbents but that the variation in performance in the entry sample is very much larger (Granstrand 1986). This would suggest that new establishment has a higher exit rate than older ones. This property, in a stylized way, is also part of the Jovanovic's (1982) model and supported by Audretsch – Mahmood 1994, 1995 and Caves' (1998) survey of empirical literature. For some, trained in standard micro production analysis this may seem counter intuitive, since for them old and obsolete plants should exit first. On this Honjo (2000) finds that new firms have greater difficulties surviving than old firms, notably in markets with a high entry rate and (therefore) intense competition. Age, however, also has a (linear) positive effect on business failure, but the square of age a negative effect. This non-linear effect means first positive and then (with age) negative effects of age on the failure rate. Audretsch (1995) observes that survival rates (over a decade) are lower in highly innovative than non-innovative markets, but entrants that have survived exhibit higher growth rates than other firms. This is also the result of Johansson (2001). Also Baldwin (1995) finds that firms that survive exhibit fast growth rates. Nevertheless, small firm entrants seem to be held back in concentrated markets, are competence intensive and "highly innovative". The opposite appears to be the case for large-firm births, but together new firm entry should be an important competitive force in the industry (Acs – Audretsch 1989). The higher exit rate of new firms than of incumbents has been demonstrated to be a property of the MOSES model and for exactly the reasons given above (Eliasson – Taymaz 2000).

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[10] On this Ueda (2000) observes that output is positively correlated with profits in aggregate data, but not in sector data. This incompatibility with the neoclassical competitive equilibrium model Ueda explains by assuming that the " sector's incumbents have market power" and therefore lower profitability in growing markets to deter entry and protect their rents.
On this already Geroski (1995) concluded among his stylized facts " that entry is generally a poor substitute for active rivalry amongst incumbent firms in a market". This may have been statistically so, but this does not mean that it is true. In some very early simulation runs on the MOSES model (Eliasson 1978a, pp.52ff) which on the basis of the Modigliani (1958) tradition were considered not interesting in a Swedish academic seminar at the time, we found that with a higher elasticity of entry with respect to local market profitability, and hence stronger entry (and hence also of exit) the market price level was competed down and industry growth expanded.

Generally speaking the direct effects of entry on aggregate output appear not to be large, and slow in coming (for a survey see Eliasson 1991b). The important long- term effects of new entry are indirect and systemic and are even slower in coming. To quantify them you need a full scale dynamic, micro based model of the entire economy (Eliasson – Taymaz 2000).

3. Theoretical Prehistory

The stylized facts have to be brought together in a consistent manner to help understanding the role of firm turnover in economic growth. You need a theory. But that theory has to give firm dynamics in markets an explicit role to play in the growth process. Let us see what we have.

Early Awareness in Theory

For a long time empirical researchers had felt content with ad hoc approaches and theorists had been reluctant to disturb the fix-point equilibrium properties of the mainstream model with the technical problems of taking on firm dynamics. Eventually, however, as empirical research grew more and more theoretically sophisticated and the documentation of empirical facts began to shake the very foundations of the mainstream model a neoclassical awakening has occurred and several recent studies within the so-called new growth theory movement, have addressed the phenomenon. They have even begun to use terms such as "Schumpeterian models", "selection" and "creative destruction". In these models, however, industries operate on their (well known) production possibilities frontiers the concept of a firm has no meaning and "price taking" is imposed by assumption. Furthermore, very special assumptions are needed (see e.g. Dasgupta – Stiglitz 1981, Jovanovic 1982, Aghion - Howitt 1992, etc.) to keep the economy in a standard Walrasian equilibrium. This means that these models only allow for the existence of entrepreneurs in such a restricted sense that it is wrong to refer to Joseph Schumpeter for intellectual support, especially to Joseph Schumpeter (1911). A theoretical point pursued in this paper is that firm dynamics and autonomous Schumpeterian (1911) entrepreneurs are not compatible with the standard notion of an exogenous equilibrium. An economic system is, of course, characterized by some kind of equilibrium properties but not a point or an exponential trajectory. Equilibrium should rather be characterized as a fairly wide region of (non-stochastic) variation and hence becomes more of a stability than an equilibrium concept (Eliasson 1983, 1984). The restrictions on autonomous entrepreneurial behavior imposed by the Walrasian equilibrium is then removed as they are in the Micro-to-Macro simulation model of an Experimentally Organized Economy we will be using. That model, furthermore, is theoretically compatible with the empirical models tested and reported on above and, hence, can be naturally related to the simulation analysis to come. The results can, furthermore, be compared with the simulated results from the model.

But there is an early history of daring pioneers. Winter (1964) opened up with his thesis of Darwinian competition and selection and the theory of the firm. Already Jenner (1966) attempted both to expand the notion of entry and to introduce entry in the pure competition neoclassical model. Following Marshall (1919) he observed that a condition for competitive equilibrium in the neoclassical model is that no firm dominates the conditions under which a new product emerges. Hence Jenner makes *product differentiation* a necessary condition for product competition and concludes that monopolies may be created internally (on the basis of product developments) in the competitive model, that they are not inconsistent with pure competition, since they are constantly controlled by competitive forces, and that they are in fact part of the competitive process. Jenner (1966) is Schumpeterian in spirit, but traditional and cautious in application. Stay within the mainstream model if you want to be published. Jenner's spirit, however, was not compatible with the neoclassical model. Jenner (1966) furthermore was a precursor of the *contestable market* story of Baumol (1982) who faced the same problem and solved it by being as conservative. But Jenner's (1966) analysis was more broadly conceived. He addressed *actual* competition through entry, not only potential competition and he brought the notion of competitive entry to within the firm. Part of Jenner's analysis, therefore, emerges in the " product selection, fixed cost" analysis of Spence (1976). By arguing that entry and market behavior are first and foremost a matter of product introduction, and only secondly a matter of new plant and firm establishment both Jenner (1966) and Spence (1976) argue that *there is far more growth generating entry than revealed by new plant and firm entry* (see further Eliasson 1991b). But both Jenner (1966) and Winter (1964) were too early for a conservative profession and they have largely disappeared from the reference lists of " modern" economists addressing the same problems in similar ways. In fact, as we will see, both Jenner (1966) and Winter (1964) may still be ahead of the "moderns" in relevance.

Literature offers three well known exogenous equilibrium approaches to the firm turnover / growth theme. We have (1) the Baumol (1982) *contestable market* story, the (2) neo Schumpeterian/neoclassical *new growth model* of Romer (1986) and Aghion-Howitt (1992) and (3) the *Jovanovic*-Pakes approaches. They are all neoclassical conservatives in tailoring their assumptions in order not to get out of exogenous equilibrium.

Contestable markets

The problem with entry and exit in exogenous equilibrium analysis is that there are transactions costs associated with the process and that the optimal production structure becomes dependent on these transactions costs. The standard solution is to assume transactions costs to be zero. Baumol-Panzar-Willig (1982) did that by assuming entry to be virtual, i.e. it never occurred. But since it could occur producers never extracted the monopoly rents possible in the absence of competitive entry. This assumption was of course, widely criticized as unrealistic, e.g. by Shepherd (1984). How can competitive entry that cannot occur ex post be credible.

Dasgupta-Stiglitz (1981) tried a more clever trick by assuming zero transactions costs and that an exogenous inflow of best practice technology exactly replaces the relative cost structure of exiting low performance technologies. Under the assumed iso-elastic demand curve an exogenous long-run growth path driven by the difference in performance between entering and exiting technologies and independent of the "organization " of production can be shown to exist. Here we can take note of the fact that du Rietz and Englund (1980) attempted to solve the same equilibrium problem using very similar assumptions[11].

[11] In practice identical assumptions. Instead of making assumptions about the relative cost structure of entering and exiting firms Englund (1980) made the assumptions necessary to preserve price-taking behavior before and after entry on the same price vector. This meant that he had to derive the entry intensity compatible with that exogenous price vector to obtain the optimum equilibrium growth trajectory of the industry. Such assumptions may look more unrealistic than those of Dasgupta-Stiglitz, but mathematically they are identical. In fact, the Englund (1980) approach is also mathematically close to that of Jovanovic (1982).

Jovanovic-Lach (1989) use a more sophisticated solution to stay within exogenous equilibrium mathematics (See Eliasson 1991b). Their trick is to make the Arrow (1962) assumption of perfect foresight. Learning by doing then creates predictable differentiable qualities of agents. J-L observe that probit-type or epidemic models exhibit S-type diffusion paths of innovation if heterogeneity among adopters is assumed and continue to show that agents can acquire the needed heterogeneity through learning by doing. The cost advantages achieved are then appropriated by later entrants that drive down costs and prices and eventually also the temporary monopoly profits earned by the early entrants, who eventually exit. Hence, exogenous learning-by-doing cost reductions drive the model, which stabilizes, on an equilibrium entry path where entry is proportional to the current flow of profits. Investment in new technology is in turn proportional to the volume of innovative entry. J-L can then show that there is a trade-off between the higher margins for early entrants and the lower margins (lower unit costs) of later entrants. Since perfect foresight has been assumed an exogenous equilibrium growth path can be shown to exist. By assuming learning-by-doing to occur in the form of cost saving entry improvements J-L find that the monopolists – through innovating or entering early and appropriating cost savings - do better for social welfare if demand is sufficiently elastic than perfect competition does. They associate this result with Schumpeter, who, however, would not have recognized their model as related to his. Of course, also J-L (1989) assume zero transactions costs.

New growth modeling

While the theoretical role of entry in the static neoclassical model and the determinants of entry have been addressed, very little attention, perhaps none, has been paid to the role of entry and exit, or rather firm turnover in industrial dynamics and growth. The likely reason is the difficulties of accommodating firm turnover in the exogenous equilibrium neoclassical model. This is surprising since this model is by its very design not suitable for, and in fact misleading when used for analyzing the role of firm dynamics in macroeconomic change. So why should you use it? Hence, Eliasson (1991b) concludes, dynamic simulation modeling is the only reliable approach. Not everybody agrees with this, however. Aghion-Howitt (1992) use a so called new growth theory model to incorporate firm turnover in a macro economic growth model. Since they call it a model of " creative destruction" a critical comment is warranted. The Aghion-Howitt model in fact carries a pedagogical value. Once you have looked through the elegant presentation it can be set in glaring contrast to our final model analysis.

The A-H (1992) model draws directly on the Romer (1986,1990) so called new growth model literature. Investment in R&D is assumed to yield a random sequence of innovations (technologically defined) that creates a (temporary) monopoly sequence of rents that last until a new random sequence flow of innovations kills off the rents. The innovations, however, shift productivity upwards for ever, and there are no investment mistakes as far as can be understood from the paper. All markets are (assumed to be) perfectly competitive, except that for intermediate goods, or (in this case) innovations. Hence, the notion of a firm becomes irrelevant, even though the authors keep using the term. Also, there is the implicit assumption (not spelled out) that there are no transactions costs associated with the R&D, innovation supply and introduction process. Hence, perfect foresight rules, and a rational expectations type stationary exogenous equilibrium can be shown to exist. A small technical problem however, exists about how to deal with the not perfectly competitive intermediate market for innovations. To demonstrate the existence of an exogenous equilibrium A-H assume that wages for workers in that market are equal to monopoly profits for innovations. Hence, total value created is always completely exhausted by payments to the factors of production. Creative destruction in the A-H model now becomes synonymous to the creation of new rents and the destruction of old innovation rents. All real activities are assumed to be independent of this stochastic rent creation and destruction, except, that the flow of innovations permanently upgrades productivity.[12] A.H (1992, 336) then show that the stochastic process driving output is non-stationary.[13] In principle the assumptions made are the same as those in Dasgupta-Stiglitz (1981). The A-H claim (on page 323) that this is endogenous growth generated by innovations that improve the *quality* of products is, however, a bit misleading. As in the MOSES model we will use this refer to they mean the quality of the one intermediate product. That intermediate product in turn affects the productivity of producing the perfectly homogenous final products of their model.

The Jovanovic Approach

Jovanovic (1982) offers a selection model of industry evolution based on Bayesian learning and (assumed) perfect foresight to explain observed "deviations from the proportional growth law", i.e. that firm growth is independent of size, or a drawing from a lottery, first formulated by Gibrat (1930,1931) and empirically tested again by Simon-Bonini (1958) and others. The policy implications of that law are far reaching. If true we don't have to worry, as Schumpeter (1942) did, about inevitable firm concentration. Jovanovic (1982) offers a theory of " noisy" selection to explain these deviations. To set the scene J. assumes an infinite number of firms (of " zero measure"). Hence, no single firm can influence the exogenous output price and price taking behavior has been assumed. Firms are also assumed to know the entire " equilibrium price sequence". Each firm has a true performance parameter that it does not know, except that it is a drawing from a normal distribution the parameters, which it knows. The firm passively learns about its performance parameter with the passage of time. It maximizes its expected present value, given what it knows and J. goes on to demonstrate that a unique industry output equilibrium exist for the exogenous price sequence where the discounted sum of consumer and producer surpluses is maximized. Then the net present value of entry is zero or negative and doesn't occur. The optimum situation is identical to that of the Walrasian model. One can talk about an auctioneer or central planner who " has exactly the same information as is collectively available to firms" (op. cit. p.658). This central planner assigns the entry and exit and the output of each firm. There are no transactions costs and no business mistakes. The proof is complicated but in the end J. demonstrates that the infinitely small firms have higher and more variable growth rates than the infinitely small large firms, but that this property diminishes with size. There is, however, a selection bias to account for in the sense that small firms have a higher probability of failing (exiting) and that those exiting firms, because of their bad performance parameters, would have been slow growing if they had not exited.

Mathematically the J-model can be seen as a filter fed with firms with a heterogeneous, to them unknown, performance potential by prior specification that gradually weeds out low

[12] There is assumed to be no matching negative real effect of the rent destruction process.

[13] Mathematically this occurs for the following reason. Log income is enhanced through equally large innovations steps that, however, occur at different times determined by a Poisson process, see 2.1 and 2.3 on page 321.

performers and entering (by the same prior specification) low performers. This “ noisy” selection process, J. claims, generates output that accords with observed data.

One could also conclude that firms in the J. model should be able to insure themselves from bad performance parameters on the fact that they know the normal distribution of the parameters, a conclusion Knight (1921) would not have been happy to see.

Pakes-Ericson (1998) come up with a variation of the Jovanovic (1982) model, or rather two “ alternative models of firm dynamics”, one being based on the passive Bayesian learning device of Jovanovic (1982) the other on their own active R&D investment learning that upgrades the exploration of a given bounded, ordered and countable state space. Constant (exogenous) input prices are assumed and firms act “ so as to maximize the expected discounted value of future net cash flows conditional on current information” (op. cit. p.9). Since the profit flows are stochastic ex-ante (expected) profits and ex-post profits are identical in expectation.

Firms, following Jovanovic (1982) are endowed at birth with a set of time-invariant and to them unknown parameters that determine the distribution of their profit streams. The firm, however, is assumed to know the distribution from which the value of its profit determining characteristic is drawn that determines its ex post profit outcome

Under “ active learning” P-E firms can, in addition, invest in R&D and improve the value of the parameters which determines the distribution of its (ex post) profits. The effect of such investment on this parameter is stochastic, and (hence, our comment) does not conflict with the exogenous equilibrium of the model.
The two models are built on the four primitives (assumptions); (1) a prior distribution of profits generating characteristics, call it initial conditions, (2) a sequence of random variables, (3) a family of distributions of these sequences, one for each characteristics and (4) a pay-off function. The pay-off function is very general (P-E 1995, p. 57) assuming only that “profits” depend positively on the relative performance (“productivity”) positions of the firm and negatively on the structure of the market (read: the number of competing firms).[14] Entry conditions in (P-E 1995, p. 57) are determined by the structure of the market, the initial investment requirements and a stochastic performance characteristic that is a drawing from a given (and known) distribution. Hence, entrants are given pay-off functions identical to the pay-off function of incumbent firms mentioned above. They differ, however, by their statistically determined performance. This is identical to the entry function in the MOSES model, except that new entrants in the P-E (1995) model first make the drawing from a known distribution and *then know their performance* for sure barring a stochastic error. MOSES firms have a prior perception of their performance, but the outcome depends on how they behave, given their characteristics (see Hanson 1989).

Firms in the P-E 1995 model do not exit when they run out of net worth, or encounter an unacceptable profit situation as in the micro to macro model that we use in the next section, but stochastically according to an empirical hazard function that depends on firm performance characteristics.

An important analytic result can be drawn from this presentation. Firm behavior is not experimental in the sense (of Eliasson 1992 and the Micro- to- Macro model of the next section and) that they enact strategic business experiments to be tested in the market. Firms cannot fail because of strategic business mistakes, only randomly.

[14] Of the MOSES specification in Eliasson (1978), Hanson (1989, pp. 213-244) and Taymaz (1991a).

Pakes-Ericson (1998, p.4) argue that their models " are " complete" in the sense that if we were willing to specify functional forms for their primitives they would imply dynamic equilibrium which could, at least in principle, be computed and numerically analyzed ". P-E (1998) don't do that, but they are probably right since the model implies (1) a bounded convex state space, (2) costless exploration and other transactions, (3) exogenously given prices and (4) a pay off function that short circuits all demand feed back. Simulating this model would probably make it converge on some kind of " equilibrium" in the form of distributions of firm characteristics or perhaps a collapse of all structures. This simulation would not be technically uncomplicated and the outcome hardly interesting.
The problem with all these sophisticated modeling efforts, however, is that by demonstrating theoretically that two exogenous entry flows are associated with two different exogenous equilibrium growth paths, growth has not been explained, at least not by the stylized facts reported from empirical studies. That explanation requires that firm behavior in dynamic markets or aggregation over dynamic markets is made explicit, the price taking assumption is given up and any equilibrium concept used is made dependent on market transactions cost (Day-Eliasson 1986).

We agree with Jenner (1966) that the entry and exit process should be taken down to within the firm for a true representation of growth through the Schumpeterian creative destruction or Table 1. Hence, also mergers are part of the dynamics of resource reallocation (Eliasson–Eliasson 2002, Jovanovic-Rousseau 2002). This, however, makes both the distinction between the firm and the market, and the problem of determining the optimal allocation undetermined. We are confronted with a constantly ongoing experimental process.
Non-stochastic business mistakes are not allowed in any of the above neoclassical models because part of the market transactions costs influences any equilibrium growth trajectory (Eliasson-Eliasson 2002). Also, even though the P-E models generate distributions of firms that can be tested against data, this dynamics" is not brought together in the form of industry or GNP growth trajectories. To capture this a different theory and a new concept of creative destruction is needed. Let us, therefore, give up the limiting assumptions of mainstream economics and turn to an entirely different model.

4. The Entry and Exit processes

Firm turnover involves innovative entry, learning and imitation, enforced reorganization and competitive exit, together making up the Schumpeterian creative destruction process of Table 1. This process, which is explicit in the micro macro simulation model MOSES may or may not generate macroeconomic growth, depending on economic circumstances endogenous in the model.

(Table 1 in about here)

Economic Growth through Competitive Selection

One could say that the four mechanisms of Schumpeterian Creative Destruction in Table 1 updates a set of performance characteristics represented each period through the rankings of as many Salter curves (see Figure 2). Under positive circumstances (incentives, competition, competence) the Salter curves are shifted outwards. Economic growth occurs. This positive outcome is, however, not guaranteed. Circumstances might be negative and destruction dominate. Stagnation might follow instead.

Incentives and competition based on the institutions of the economy guide this selection process and decide whether investment and growth or concentration and eventual stagnation will occur. Firms are guided in their investment decisions by the expected return to capital over and above the market interest rate. The key problem of growth is (Eliasson 2001, 2003) that winners are identified and carried on to industrial scale production and distribution.

Short term production decisions are guided by a criterion called Maintain or Improve Profits (MIP). Firms constantly climb expected profit hills that change from period to period because of the ongoing climbing traffic and keep recalculating their expected profits as circumstances change and as they learn from experience (Eliasson 1976, p.236 f, 291f, 1977, 1991a). The more expectational mistakes the firms make the more cautious they become. Since the state space or the opportunities space of the MOSES model keeps expanding as it is being explored by firms (the *Särimner effect,* Eliasson 1987, p 29, and 1996, p.27f) *behavior can be characterized as profit hill climbing in a volcanically unstable landscape, in which eruptions are constantly being triggered by the ongoing climbing traffic.*

(Figure 1 in here)

The concepts of entry and exit

The concepts of entry and exit are well defined in the MOSES model as "whole" firms that enter or leave. Also factors of productions used in exiting firms (labor and machines) are recycled over the market to other firms. In reality, however, entry and exit take on more diverse forms. Jenner (1966), in fact, wanted to see the launching of a new product as a new entry, and firms may acquire parts of other firms, or spin off parts of itself as new entrants. Strategic acquisitions and divestures have become an increasingly important phenomenon in industrial dynamics (Eliasson-Eliasson 2004). Similarly, the shutting down of a factory as well as the termination of a product line in a big firm should count as exit. This is perfectly compatible with our theory as expressed in Table 1, but such a fine statistical resolution takes us beyond availability of data, even though some empirical studies look at corporate spin-offs (e.g. Du Rietz 1975).

The actual occurrence of the phenomenon becomes difficult to define on the exit side. A complete reorganization of a firm with many subsidiaries, including divestures and new acquisitions should count as a complex entry and exit process, and may to some extent appear in statistics as the disappearance of old, and the opening up of new firm identification numbers. Only part of this activity will, however, be captured statistically. The MOSES model, as it is currently constructed cannot deal with this.

Entry

In this analysis we use the following entry rate specification.

Entry = $s(\alpha,\pi)$

where $s(.)$ is a stochastic function, α is the exogenous entry parameter, and π the average rate of return in the appropriate market.

We assume a uniform distribution of size around the average entry size that is assumed to be less than the average of incumbents. In our experiments the size of new entering firms can vary from five percent of the average size of incumbents (in terms of number of employees) to 25 percent. Hence, the average size of entrants is around 15 percent of the average size of incumbents.

Firm performance is measured by labor and capital productivity (called TEC and INVEFF respectively in the model) and by the rate of return. To specify the characteristics of new firms we use the observation (Granstrand 1986) that average labor productivity of a sample of new firms is lower than the same average of incumbent firms. Soon data will be available to tell how much lower and how the distribution of the sample of entrants differs from that of the population of incumbent firms.

In the first experiment below we have set the size of the average firm entrant (large entrants) at 15 percent of the average incumbent measured by labor employed. The new data becoming available suggests that this is somewhat large for Sweden with its very large firms. The average size of an entrant in engineering industry should rather be somewhere between 5 and 10 percent.

It is, however, not possible to induce the high rates of entry that we need to destabilize the price system endogenously through indirect incentives only. Hence, the very high rates of entry in some experiments have been exogenously imposed by changing the characteristics of the entering firms and modifying the stochastic algorithms that determine the rate of arrival of new entrants.

In the entry experiments, the value of the exogenous entry parameter, α, has been increased gradually to test for the effects of the entry rate on long-run macroeconomic performance. The size of new firms in terms of the number of employees is drawn randomly from a uniform distribution. As mentioned, the boundaries of the distribution are set at the 5 percent (lower limit) and 25 percent (upper limit) of the average size of the incumbent firms.

The technological characteristics of the new firms are also determined randomly, using genetic algorithms (see further Ballot – Taymaz 1998). There are 100 technologies that firms can learn about, recombine and use. These technologies are indexed from 1 to 100 by ascending technological level. The probability that the i^{th} firm will enter with technology j is defined as follows:

$$p^{T}_{ij} = f(|j-T_{ave}|, p_j)$$

where T_{ave} is the average technological level for all firms in the market and p_j the proportion of incumbent firms using technology j. In other words, new firms tend to enter with technologies that are close to the market average and adopted by many firms. However, it is still probable that a new firm may enter with the best technology, i.e. technology 100. Therefore, entry encourages diversity that is likely to include better technologies. On the other hand, increasing returns to adoption generated by the imitation process force firms to cluster around the same technology, and reduces diversity. The entry process, therefore, has a tendency to raise the rate of technological change by creating diversity, but it also causes reallocation of resources towards, in some cases, low tech new firms (see Ballot – Taymaz 1998).

The role of exits

The *exit* process is more easy to specify. It is fully endogenized and occurs when firms have been experiencing a bad profit development for considerable time. The model allows for a continuum of exit behavior between fast exit when a firm has had a recorded profitability below targets for a number of years and, at the other end, and at the latest (slow exit) when net worth has vanished. This means that the exit rate might be negatively correlated with the general profitability in the market (which in fact has been econometrically established to be the case, Siegfried – Evans 1994) because firms operating in low-profit markets generally tend to show lower profitability. Exit, hence, can be slow or more or less fast. Exit can be forced by competition and competition is enhanced by the entry of superior firms.

The positive macroeconomic effects of a faster exit rate may demand a separate explanation. How come the disappearance of firms adds to output? This paradoxical effect is generated in a highly non-linear fashion over the longer run, but only under particular circumstances, i.e. it is positive if released resources are reallocated to growing firms, and the more so the more productive the receiving firm and the less productive the disappearing firms. We have an example of the macroeconomic output effects of dynamic resource allocation. This effect is difficult to demonstrate econometrically on the short time series data available. We have not seen any references to such a study. It has been demonstrated to be a property of the MOSES model by Eliasson – Taymaz (2000). The clear result of that study was that a *long term,* positive outcome of entry required a significant exit rate and a fast reallocation of labor over the market. Furthermore, as we will soon see, the experimental design that generated the negative long-run effects of fast entry was a slowing of the exit process.

Exit, hence, is an integral part of the firm entry and reorganization process that together define Schumpeterian creative destruction. Exit is necessary to release resources for non-inflationary new firm formation and growth. Exit is a natural consequence of the business mistakes that occur constantly in the model of the experimentally organized economy. Stable macroeconomic growth, however, requires some balance between entry and exit frequencies.

4. Results from simulations

Each experiment is rerun by gradually increasing the entry parameters. The curve shows the average value of GNP in the experiments, and the trend line shows the regression "curve" estimated by regressing the GNP level on a quadratic function of the entry parameter.

Figure 6A shows the entry rate. The entry rate is defined as the proportion of *net* entrants at the end of the simulation (year 75). As may be expected, the entry rate increases almost monotonically by the value of the entry parameter to reach some 80 percent. Figure 6B shows the effects of the entry parameter on the exit rate that is defined as the ratio between the number of exits and the number of firms at the beginning of the simulation (there are 225 firms at year 0). As expected, the entry rate also increases the exit rate because of the tough competition it imposes in the markets.[15]

Experiments run (by quarter) for 75 years. Micro relationships are partly determined econometrically. The model is, furthermore, based on a separate firm survey carried out by the Federation of Swedish industries since 1975 (see Albrecht 1992). The remaining parameters in the model have been calibrated on historic data (see Albrecht et al. 1992, and Taymaz 1991b). The parameters in the entry function are moved such that the entry rate is steadily increased. The exit rate is completely endogenized, but faster and slower exit can be specified in terms of the criteria model firm management applies to close down a firm.

The endogenized balance between entry and exit is shown in Figures 6. To demonstrate the change over from the approximately linear to the non-linear macroeconomic response to firm turnover we present four sets of figures showing the GNP levels after 15, 35, 55 and 75 years respectively (Figures 2, 3, 4, 5A). For 75 years also manufacturing output is shown (Figure 5B).

Up to 15 years the levels of GNP increase proportionally with the rates of entry (and exit, Figure 2). Decreasing returns to further entry begin to show as a small down-bending of the trend curve after 35 years, which becomes pronounced after 55 years and very striking at 75 years both for GNP and manufacturing output. The downward bending at year 75 also comes at a lower turnover rate than at years 31 and 55.

(Figures 2, 3, 4, 5A, B and 6A, B in about here)

For our purposes it is sufficient to establish the existence of this non-linear negative effect under the dynamic assumptions of the simulation. The negative effects take a long time in coming but the final surge can become very strong.

It is not meaningful at this stage to draw any further quantitative conclusions: for practical reasons the number of firms populating the model is only a tiny fraction of the number of firms of the real Swedish economy. The scales of the entry, exit and entry parameters in Figures 6 do not say anything about the rate at which firms are turned over per period or year. We can observe that there is a parallel increase in the entry and exit rates, as expected. The long-term growth to the 75-year horizon peaks at an entry parameter between 100 and 150. At that turnover level some 60 percent of the end population of firms are new. Many new entrants, however, have exited during the 75-year period. The

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[15] This effect has been a property of the model through all its versions. See Eliasson 1978, pp. 52 ff.

exit rate in the C&C industry is, in fact, very high. Johansson (2001) finds that only 60 percent of the original number of firms remains after 5 years. [16]

On the exit side (Figure 6B) long-term (75 years) output peaks when exits number some 43-44 percent of the initial (year 0) population of 225 firms. While both the number of entrants and exits increases, the number of entrants is much larger than the number of exits. On the entry side, the "optimal" number in the model simulation amounts to some 1.1 percent of the stock of firms per year, which is slightly above the average of just below 1 percent in the 1970s and 1980s in Swedish manufacturing (Andersson et al. 1993, p. 95). We have no corresponding exit data and apparently the exit rate simulated is much lower (Figure 6C). We can only say that if the scale would be calibrated to the level of the real economy the proportion of firms replaced through Schumpeterian creative destruction each period would be very large as you go to the right in Figures 6. There is, however, the possibility, indicated earlier in the text, that the strong negative bend on the growth curve at high rates of entry after 50 years depends on a too low exit rate (unbalanced turnover) and would go away if we speed up the rate of exit by making management more profit conscious. This experiment has not been run but the hypothesis indicated will be tested later. Hence, the extreme bending down in Figures 5A, B may be extremely unlikely in reality because such high entry rates rarely occur for such long periods. But the effect is there to show. To capture it in a time series analysis on entry, exit and growth rates, generated by the model over a 75 year period, a very different model than the standard linear regression model would, however, be needed.

[16] This is subject to a separate analysis in which the C&C industry is introduced as a separate industry/market in the MOSES model.

5. Concluding policy discussion

Literature increasingly reports on a strong econometric support for a positive linear relationship between entry and growth and also on a positive influence on production growth of a balanced entry and exit process. Firm turnover, however, involves structural change and above some limit the rate of structural change will begin to affect the reliability of price signaling in markets negatively. To test for a long-run, non-linear negative influence of a very fast and (perhaps) unbalanced firm turnover process very long time series data that are not available are needed. Simulation has been the only way of establishing the possible existence of this phenomenon. It may even be so that the firm turnover rate needed to generate disturbances in the price system has to be so extreme that it "cannot occur" endogenously in reality. If so, the negative relationship will never be observable. The micro-to-macro model of the Swedish economy is found to embody the expected non-linear characteristics and for the reasons hypothesized. The output growth curve began to bend down after about half a century at entry rates that were not far above recorded entry rates during the past 20 years.

Long-term sustained, fast and stable growth in macro economic output is a desired ambition of industrial policy. We can say that the simulation experiments reported on directly perform the transformation of Table 1 into industrial macro change, firms being guided in their production decisions by a profitability criterion called maintain or Improve Profits (MIP). Growth occurs if winning projects/firms are opting for investment and growth and losers are contracting or shutting down. This ideal emergence may not always be the outcome, however. Long – term investment decisions in MOSES firms are guided by the expected return to capital over the market interest rate. The MIP criterion accepts that firms are temporarily inferior performers by that rate of return criterion, but force them to constantly improve their performance. Hence, if firms cannot meet their own short-term profit standards they may decide to contract operations rather than invest and expand. In this particular set of experiments unreliable price signaling in markets may lead both to mistaken production and investment decisions and tilt an increasing number of firms onto a lower than possible growth path. Similarly, unbalanced growth, with too few exits may raise factor prices and tilt expansive firms onto lower growth paths.[17]

We have demonstrated in this paper that faster for some time may mean significantly less later, at a stage when it may be impossible to correct the situation. Sustainability involves an "optimization" over a very long time span. An interesting question is if the policy maker should have a role in that optimization decision. The first problem to solve, then, is to figure out the reasons for the long-run negative effect of fast turnover on growth. Wouldn't the economy have developed endogenous market correction mechanisms that eliminate such long-run effects? *First* of all, the negative effects take a long time in coming. They cannot be discovered ahead of time by analytical methods[18] so there is no opportunity for policy makers to act ahead with precise targeting of counter measures. *Second*, even if they had known what was coming, policy makers would not know what to do (Eliasson – Taymaz 1992). *Third*, the low entry rates per year should be seen in relation to the total firm population. The model firm population features much less heterogeneity than the real

[17] These negative effects on growth came out clearly in early model experiments on the Swedish subsidy program. See Carlsson (1983).
[18] This is a property of chaotic behavior.

firm population. Hence, it is not as robust and the downward bending of the curve should occur at a lower entry rate than in reality. Accounting for that one might perhaps say that the large entry rates to the right in Figure 6A, involving a very large increase in the firm population are not sustainable for an entire economy for such a long period, only locally and then the realistic range of entry over a long period would be just above or just below the optimum, but not so far off. Then negative effects may go undiscovered for decades. This interpretation is more in line with the Swedish experience with a steady lowering of new firm formation per year from a peak around 3 percent in the 1920s to a low around 0.5 percent in the 1990s (Andersson et al. 1993, p. 95). To present a negative employment effect from the increasingly obsolete industrial structure the exit process was slowed by subsidies, adding worse to bad, notably by subsidizing the worst performers that were also paying the highest wages (steel and shipyards; Carlsson 1983). The negative influences began to show and be understood only as late as the early 1990s. In fact, Andersson et al. (1993) presented the first real analysis of the Swedish economy in which this problem was seriously addressed.

Table 1. The four mechanisms of Schumpeterian creative destruction and economic growth

1. Innovative entry
   enforces (through competition)
2. Reorganization
3. Rationalization
   or
4. Exit (bankruptcy and/or shut down)

Source: "Företagens, institutionernas och marknadernas roll i Sverige", Appendix 6 in A. Lindbeck (ed.), *Nya villkor för ekonomi och politik* (SOU 1993:16) and G. Eliasson (1996a, p. 45).

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