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Micro Heterogeneity of Firms and the Stability of Industrial Growth

by

Gunnar Eliasson

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by

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1. INTRODUCTION

It is argued here that economic growth can only be explained at the fine levels of aggregation where decisions related to the long-run future are taken. This poses formidable observation and measurement problems. We advocate an intermediate, empirically manageable, micro-macro (M-M) approach in which the business unit is introduced as a financial entity that makes independent decisions on markets, but also operates internal, well defined statistical information systems. A M-M model has been developed on these principles at the Industrial Institute for Economic and Social Research (IUI) in Stockholm.

The business unit in this model operates on its initial endowment of technical and commercial knowledge and what it can add by participating in an exogenous, innovative process and through investing whatever resources it generates, or has access to. Innovative activities generate a rate of return, "a rent" above the alternative return available on financial investments in the market.

The behavior of the (financial) business units is coordinated by markets for products, labor and capital. The overall market regime of the economy is characterized by the intensity of competitive processes and of innovative activity (search for new opportunities).

The market regime can be varied by setting a number of parameters in the M-M model that regulate the speed of adjustments of micro units and information transmission in the economy. The character of information handling and decision making at the micro level determines (1) the size and structure of the business organization as a financial unit, (2) the generation and distribution of temporary rents across the economic system and (3) capital market competition; three sets of processes that are critical for understanding macroeconomic growth.

The Schumpeterian entrepreneur is introduced as an exogenous innovator that creates temporary rents to the business unit. The Wicksellian (1898) idea of a cumulative inflationary process, fueled by a capital market disequilibrium, is given a long-term micro interpretation. By integrating it with the exogenous innovative activity in financially defined micro units (firms) the behavior of which is coordinated by markets, we will obtain an endogenous explanation of the growth cycle. We argue that economic growth cannot be (endogenously) explained except in a market disequilibrium context. The growth process contains as a latent possibility the now-and-then occurrence of crises.

In our model disequilibrium is based on a theory where micro units operate under the constraints of exogenous technological factors and the joint endogenous action of all micro units, the "macro economy". The resulting model economy has been calibrated using Swedish time series data and initial data from 140 real Swedish business units.

In Section 2, I outline the basic ingredients of my M-M theory. Section 3 describes the specific way these ingredients are incorporated in our MOdel of the Swedish Economic System (MOSES). Section 4 presents simulation experiments with our current operating version of the model.

2. INGREDIENTS OF A MICRO-MACRO THEORY

In order to have satisfactory predictive power, economic theory has to be dynamic and incorporate empirically defined variables. Moreover, a growth theory pretending to explain the interaction between short- and medium-term cyclical behavior of an economy and long-term economic growth has to capture innovative mechanisms that create new technologies as well as explain how the results of innovations enter firms through various forms of investment. Such a theory also has to embody the competitive market regime that determines prices and short-term productivity performance within firms and between firms. To do that one has to draw on several bodies of theory that have never been fully integrated before.

2.1 Business Behavior and Organization

To begin it is assumed that decision makers (firms and households) act on the basis of rules of thumb applied to available information. The rules chosen are based on observed business practice (Eliasson 1976a). They are rational in the sense that they are not contradictory (inconsistent) and never intentionally lead to a diminished ex ante objective position. The internal administrative process is of the gradient type and based on limited information. The firm gradually moves in the direction that appears profitable, rather than attempting the impossible to survey its entire environment to find a global optimum in one stroke. Under certain conditions this behavior should converge to the special case of marginalism (cf. Day 1967). Such behavior reflects "bounded rationality" (see Simon 1955, 1972).

Ex post rational decisions can be both inconsistent and value diminishing, due to incomplete or misinterpreted information. Rules are, however, also adjusted or changed, if they repeatedly lead to diminished value positions. Good theory recognizes that such rules can change as a result of accumulated experience (Winter 1971) and that experience may lead to search for new or better information.

The combined decisions of many agents define the competitive process in three markets (the product, the labor and the capital market) and also determine the corresponding three sets of prices and quantities ((price, output), (wage, employment), (interest rate, wealth)).

The essence of productivity growth consists in combining existing factors in new ways and/or combining existing factors with new factors. This combinatorial activity takes place within existing institutions, between existing institutions, through the entry of new institutions and through the disintegration of, and recombination of, institutional parts. Up to a certain level combinatorial activity is most efficiently managed through an administrative control system, the firm (Coase 1937). Above that level markets are more efficient and tend to break down oversized institutions to optimal levels of aggregation. The complexity of potential combinatorial activity at any level, including the interior of individual institutions, makes all decision makers' environments unpredictable in principle.

Markets are the vehicles for combinatorial activity. The dominant market in this respect is the capital market which deals with the financing of institutional change. Hence the capital market is also decisive in limiting the size of the business organization. The firm attracts financial resources for growth when it can achieve a higher return on assets through its interior administration, than the market provides, and leaks resources in the opposite case (Eliasson 1976a, Chapter XI, especially p. 256).

2.2 Investment and the Capital Market

Short-term inputs into the production system are secured through labor and product market competition among firms and through a "principal-agent" relationship between top level management (Corporate Headquarters) on the one hand and profit center management within the firms on the other.

Long-term growth of the firm, and the extent to which exogenous innovative "talent" enters, is determined through the investment decision of the individual firm. Investment should here be defined broadly to include spending on R&D, training and education of employees, marketing investments, etc. Value growth of the firm depends importantly on the combined ability of the firm to earn a return on investment, and the willingness of savers to part with their current resources in return for more real resources in the future. This amounts to a market confrontation of the expected nominal returns to investment of business units, and the market interest rate. Hence, we can talk about a micro version of Wicksell's (1898, 1906) cumulative process, generated by a capital market disequilibrium, or a continuous turnover of temporary innovative (Schumpeterian) rents across the firm population.

The "savers" or "capitalists", including the firms, (through the intermediation of the capital market) impose a rate of return requirement on the firms by moving financial resources to the best performers. In addition an exit function forces them to comply in the longer term. The rent structure distributes investment across the firm population, and the nature of the capital market process is to compete these rents away.

We enter both the entrepreneur into the business unit - as already described - and the "owner". The latter is symbolically there by virtue of a contract. But this formality is less important than it is to specify the economic function of the owner, namely to be tough on firm management, by exercising a rate of return requirement (to be explained below), to withdraw financial resources if the yield is not satisfactory, but also to possess enough innovative perception to spot the new opportunities, or business combinations, towards which resources should be channeled.

This approach is manifested more or less in the micro-to-macro model (called MOSES). It relates management technology as vested in a particular contract (the financial firm unit) via the capital market to its ultimate monitor (principal), the firm owners, through labor, product and capital markets. It appears that the imposition of rate of return requirements and/or barring of low performing business units from access to external resources, thus forcing exits - or creative destruction, to use a Schumpeterian term - may be as important in the growth process as the introduction of new technology through new investment.

2.3 Releasing the Technological Potential

The micro-to-macro approach allows us to model dynamic allocation processes and to test - through simulation experiments - Ashton's (1948) suggestion, that the industrial revolution had its origin in financial innovations that pooled savers' resources in the market and made them available at a lower ("real") interest rate than was possible without the innovation. This released the technological potential already existing in the form of rapid growth in output.

Efficient allocation requires exit. If scrapping of capital installations (or creative destruction) is not efficient because of capital market imperfections or too low rate of return requirements, output growth is held back at the upper end of the performance spectrum. This negative effect results from failure to release scarce resources, notably labor, thus making them less available and hence more expensive. When realistically represented the initial performance dispersion across the firm population as a rule contains a very large potential for productivity enhancement at the macro level through restructuring, exit of low performers and new investment in the best technologies. Eventually, such a restructuring under a constant, upper limit technology assumption and an imposed rate of return target forces such concentration and such performance equality on the firm population that the entire M-M economy becomes inherently unstable (Eliasson 1983). The introduction of new superior technologies via investment in existing firms or through new entry essentially smoothes or stabilizes the macroeconomic growth process over several decades, rather than generating year-to-year, or even decade-to-decade, growth.

2.4 Entrepreneurship and Evolution

Joseph Schumpeter associated innovative activity with the existence of an entrepreneur - originally conceived of as a "deus ex machina" that served the firm, and the economy, with innovative inputs. Nelson and Winter have, in articles and in a recent book (1982), probed deeper into the nature of innovative activity using a Darwinian process. They contrast evolutionary modelling to orthodox modelling based on the assumed existence of a global objective function, a well defined and known production choice set, maximizing behavior and (hence) a concern for the equilibrium characteristics of the model. Evolutionary modelling starts from Gordon's (1945) observation that the core business decisions of economic theory are taken in delegated, middle management routines, while top executives attempt to solve other, less structured but more important problems. The firms are guided by a set of search routines keyed on profitability. The "entrepreneur" is manifest in the nature of search routines that enhance profitability performance.

Fama (1980), being an exponent of the burgeoning principal agent literature, calls into question the need at all for both an entrepreneur, and ownership, in the theory of the firm. The "two functions" usually attributed to the entrepreneur - management and risk bearing - as well as the ownership function, he argues, can all be "treated as naturally separate factors within the set of contracts called a firm".

Fama also argues that the concept of an entrepreneur prevents us from viewing management and risk bearing as separate factors of production. Hence, there is not even a need for explicit contracts. With this emphasis of markets, the concepts of the firm and the entrepreneur become blurred: they even cease to exist.

Both the Nelson-Winter and the Fama arguments are compelling on their own assumptions, but as they stand they are mutually incompatible. The conflict is, however, mostly verbal. Schumpeter never thought of his entrepreneur as primarily a risk bearer or an owner. His entrepreneur existed on the basis of his ability to conceive new combinations that could not be derived logically from existing explicit knowledge. The entrepreneur, hence, was created as an exogenous, non-economic force, to represent something unknown - innovation and technological change - until it could be explained. The new combination makes the firm (with its entrepreneur) superior to the market as a decision unit. (Nelson and Winter have worked on that explanation with the obvious ambition to improve standard theory and empirical practice in economics. Fama makes this ambition all but impossible by introducing unmeasurable concepts, such as implicit contracts, with extreme detail. The entrepreneur - and what he or she does - is replaced by an even less well defined concept, "the market".)

(We take a middle position in this argument. Understanding requires good taxonomies and preferably measurement, and proxy measurements for the entrepreneur or perhaps rather the owner - capitalist. (This method to measure has to be part of theory if theory is to be taken as something more than a play with symbols.) The firm exists as a measurable entity based on a set of explicit contracts that changes through exit, entry, mergers and internal growth. The set we observe (called Volvo, Electrolux, etc.) may not be exactly the right ones, but they certainly are better than no measurements. To accommodate both the ambition of Nelson and Winter and Fama's challenge, one simply has to probe deeper into these financial entities, called firms, to understand how they are operated and how they transform themselves into new sets of contracts.)

One can object to the concept of an entrepreneur by asking what distinguishes him from all other agents in the market except demonstrated success in coming up with a new, profit yielding combination. If a large enough number of agents try, there will always be some lucky entrepreneurs. Hence, the main vehicle for technological change would be to improve the economic regime such that more agents than before are more intensively engaged in entrepreneurial activity (Dahmén-Eliasson, 1980). (This comes fairly close to the probabilistic, technology generating process that Futia (1980) calls "Schumpeterian competition".) Perhaps the economic regime could also be socially structured so as to exhibit an entrepreneurial success bias. One can always point to regions within countries that apparently perform much better in economic terms than the rest of the country, and ask why this is so. To theorize about such socio-economic mechanisms one has to come up with a set of rules for "search" or "trial and error" that can be applied generally, and that can be demonstrated to be more successful than other sets of rules on average in finding new, more productive or more profitable business combinations. A particularly challenging idea has to do with a potential conflict between the optimal rule-set and rules derived from static marginalist assumptions. In a dynamically changing economic environment, it may be more important to design rules for firms that engineer constant aggressive action for improvement, that sees to it that something gets done (which is the case in the MOSES M-M economy) rather than rules that slow down action until a global optimum has been found. Problems like these pose difficult analytical tasks and have so far escaped theoretical attempts (Eliasson, 1976a, 1982). The problem of evaluating decision rules from the firm's point of view is, however, a researchable one.

2.5 Innovative Activity and Technological Change

My preferred way to disentangle various elements of entrepreneurial quality at the level of aggregation called a firm would be to view firms as imitators, learners and developers that invest in learning through R&D and contribute to the pool of global knowledge through their actual performance.

Long-term internal growth of one financial unit in the model we are going to use below is strongly governed by the innovative process that allows higher profit margins over costs at the same market prices as competitors charge, but that so far is exogenous to the firm and brought in by new investment. Hence, entrepreneurial talent in the model has been embodied in the investment decision and appears technically as an exogenous force that upgrades the quality of investment.

The existing pool of accessible technological knowledge, and the potential productivity change that can flow from it, is, however, something very subtle and conceptually difficult. It is not explained by being introduced as an exogenous force and I am not at all convinced that it can be captured by any general theory. This nature of the decisions explains why formal rate of return calculations that supposedly govern the investment decision, in fact rarely do for the really important decisions (Eliasson 1976).

New combinations of ideas, knowledge and activities associated with new investment define the major part of potential productivity increase. The possibility set of combinations at the micro-to-macro level within firms is enormous, and each decision maker knows only a tiny fraction of the whole existing set. For all practical purposes the same can be said when we move up the aggregation scale to the firm, defined as a financial unit. Overview at any level of the relevant productivity enhancing combinatorial activity is impossible, something spelled out very clearly already by von Hayek (1940, 1945) in his famed discussion with Lange (1936, 1937). At lower levels the view is restricted. At higher levels the understanding of what to do fades. The forming of organizational structures that enhance combinatorial talent and that stimulate search for new, profitable combinations hence becomes central to both business success and technological change. Nevertheless, the essence of this activity is that a tiny fraction of attempts will succeed and do wonders, and a very large fraction will fail. The nature of this game is very much determined by the ways society is put together.

The market regime inter alia "determines" how much change society is willing to accept. The innovative activity level defines the degree of curiosity of society. (Even if individuals are rational and pleasure seeking entities their utility functions are so complex that much of the explanation lies outside the domain of economics and it is very doubtful practice to introduce them as stable over time as is habitually done in economic analysis. The typical characteristic of innovative activity is its high rate of failure, but the very high payoff if it succeeds.)

(Looked at in this fashion, the extent and intensity of search for new solutions to old problems and of inventing new things and services determine the overall, average outcome of innovative activity. Things that appear to be small to begin with can later be decisive. The real creative ideas originate with individuals. There is no way to "foretell what the ideas will be or where they may arise. As an example of how impossible it is, even with simple things, to forecast the future, I have often thought of how infinitesimally small would have been the chance of any man or group of men, except the one who actually had the idea, planning to invent the common zipper" (Frank B. Jewett, President of Bell Telephone laboratories as quoted by Weiner 1983). It is appropriate to make such new innovative activities exogenous as well as the nature of its output (better butter, biological chips or super lasers) in modelling.)

Even if we have a good micro based growth model will it be possible to explain the macro effects and their distributions from known, successful innovations in the past? When looking into the future it will not be possible to say anything about what kind of technologies will develop, except that we may develop a general theory of the overall (macro) level of innovative activity of industry or of the country. The important issue is whether there is any way of explaining the number - not the distribution - of innovations.

2.6 Cycles and Institutions

Part of the Schumpeterian tradition is that waves of fundamental innovations create long-term waves of expansion and contraction in the macro economy. Even though it is still not one hundred percent demonstrated and accepted that such long cycles have, in fact, occurred in economic history,[1] a large set of dynamic economic models can be demonstrated to exhibit such properties. Schumpeter also emphasized the importance of the competitive crunch during the downswing phase of the cycle that served the purpose of weeding out low grade producers to give way for expansion of the best producers ("creative destruction").

We have broadened the concept of technological change somewhat, to include - in good Schumpeterian spirit - also improved administrative techniques within firms, and improvements (or rather changes) in economic regimes as part of the productivity enhancement process (cf. Day 1983). Within that framework we do, however, emphasize the importance of institutional transformation - and destruction(!) - as part of improved macroeconomic performance. Hence, by varying the regime defining parameters, especially those related to speeds of market arbitrage - which we can do in the model - we can generate long-term waves of expansion and contraction that appear similar to those linked to waves of technical innovations. Such regime defining specifications seem to be more dominant in explaining long-term economic growth in the model, than is pure technical change.

3. THE MICRO MARKET FOUNDATION OF THE GROWTH CYCLE - MODEL OUTLINE

3.1 Micro-to-Macro (M-M) Analysis - the Model System

We need a coherent model to illustrate analytically or computationally how the entrepreneurs and innovators, when placed in a market setting, form a driving force to create a dynamic macroeconomic growth cycle. Such a micro-to-macro (M-M) model has been developed at the Industrial Institute for Social and Economic Research (IUI) over the last six or seven years (Eliasson 1976b, 1978, 1983 etc.). It is empirically founded on real firm data (Albrecht-Lindberg 1982) and the behavioral rules of the firm are based on observed rules in real firms (Eliasson 1976a). In general the MOSES model is based on the theoretical considerations reviewed in Section 2 above. Here I am going to give a general description of the model as it is being developed.

The model system can be visualized as three sets of games;

- one <u>within</u> the firm between the owner/top management group and operating divisions
- one <u>within</u> the firm between the long and the short term
- one <u>between</u> firms in product and factor markets.

The game within the firm sets the operating departments that know <u>how</u> to do things against top management, who knows what it wants in terms of profits, but not exactly what it can get. We apply what we call the maintain or improve profitability (MIP) targeting principle. There are certain similarities in this setting to the principal (the regulator) agent (the utility) relationship analyzed by Linhart-Radner-Sinden (1983).[2]

The long- and the short-term tradeoff handles the investment and borrowing decision within the firm. Here expected returns to investment confront owners' rates of return requirements (the dividend decision) and the interest rate (the borrowing decision).

In the third game setting each firm competes with all other firms for funds in the capital market, for labor in the labor market and for customers in the product market. In the process the interest rate, wages and product prices are determined together with all quantities. In this paper we will be especially concerned with the capital market process.

Each decision unit (firm) is parameterized to react to price signals in all markets at a certain speed. Similarly, labor responds to wage offers at a certain speed. Information about price offerings can be transmitted more or less rapidly. A vector of some 20 parameters associated with each firm regulate the speed of adjustment in all three markets (Eliasson 1983). This set of parameters defines the market regime.

Investment spending in each firm follows a rate of return dependent, expected cash flow. Investment is held back by the degree of capacity utilization as described in Eliasson-Lindberg (1981).

The most important exogenous variables are:

- the foreign or domestic interest rate
- foreign (relative) prices for each market

- technical change (labor and capital productivity) associated with each new investment vintage at the firm level
- the labor force
- Government hiring.

The economy is driven forward in time by these exogenous variables only. Technical change is transformed into productivity growth through the individual firm investment and later production decisions each period. Hence, economic growth is endogenously determined under an upper, unattainable technical constraint, meaning that even if each firm operates at full capacity (in itself an unattainable state) a higher macro output would be momentarily available, if labor could be reallocated instantaneously and at no cost.

In the long term this upper constraint moves upward by new investment, and (depending on the allocation of these investments through the capital market process) many macro growth trajectories are feasible. This capital market process forms the moving force in the growth cycle.

The household consumption system is a Stone type, non-linear macro expenditure system, linked into the endogenized income flows generated in the production system.

3.2 The Fundamental Equation

Let us introduce the following accounting identity

$$\Sigma p\ Q = \Sigma p^{x} X \qquad (1)$$

for all industry. Summation is across decision units (establishments, divisions or profit centers) that produce a well defined output in quantity Q, with the price p. For that production a number of inputs, priced at p^x, are applied in quantities X. The empirical and theoretical argument is that such decision units operate relatively independently and that they need good quality internal information and database systems for that purpose that we use in our empirical applications (Section 4).

Aggregate over sets of establishments and introduce a smaller set of firms (financial units) made up of establishments.[3] Assume (for simplicity) that factor inputs consist only of labor (= L, priced at w) and capital (= K, priced at $[R + \frac{\Delta p(DUR)}{p} + \rho]$). R is the real rate of return on total capital K. p(DUR) is the capital goods price index that applies to K. ρ is a depreciation factor (assumed constant). Hence,:

$$\Sigma pQ \equiv \Sigma wL + [R + \frac{\Delta p(DUR)}{p(DUR)} + \rho]K \tag{2}$$

Insert the nominal market interest (loan) rate (r) in (2) instead of the nominal return to capital $(= R + \frac{\Delta p(DUR)}{p(DUR)})$ and (2) becomes:

$$\Sigma pQ = \Sigma wL + \Sigma(r+\rho)K + \Sigma\varepsilon K \tag{3A}$$

$$\varepsilon_i = R_i + \frac{\Delta p(DUR)}{p(DUR)} - r. \tag{3B}$$

ε_i is the temporary rent that the firm i earns over and above (or below) the market interest rate r.

For each firm $i \in (1,n)$ the nominal return to net worth (R^{NW}) can be shown to be (for proof see Eliasson 1978, p. 81-81):

$$R^{NW} = \frac{\Delta NW}{NW} + \Theta = M\alpha - \rho + \frac{\Delta p(DUR)}{p(DUR)} + \varepsilon\phi \tag{4}$$

where:

$$M = 1 - \frac{w}{p} \cdot \frac{1}{Q/L}$$

$$\alpha = \frac{pQ}{p(DUR)\ \bar{K}}$$

$$\phi = \frac{BW}{NW}$$

$$\Theta = \frac{DIV}{NW}$$

NW = net worth

BW = debt (K = BW + NW)

The nominal return (R^{NW}) to net worth or equity (= NW), the latter measured at capital reproduction costs net of nominal debt, is equal to the current rate of growth in the same net worth, plus the current dividend (DIV) payout of net worth (= Θ). It is also the sum of four components, each representing a contribution to the rate of return from a different source (see below).

Let us assume that i (signifying a firm or the smallest financial unit), is the smallest entity for which we have observable data. The firm is composed of interior units (divisions, profit centers or smaller units) that make up the financial aggregate. We know that at each point in time there exists an unknown number of other combinations of inputs at lower levels of aggregation, some of which have significantly higher productivity ($Q/L, \alpha$) properties.[4] These superior combinations materialize with time, and especially in connection with the investment process, which in this context should be viewed as adding new components to the combinatorial process at lower levels. At our present level - the lowest from which we can establish contact in the model through markets with the macro level - we are restricted to observing the financial unit.

The left hand side of Equation (4) is the sum of four components, each representing a source of profits and an organizational unit in a firm:

The contribution to R^{NW} from:

-	operations (Division Operating Department):	$M\alpha$
-	calculation of overheads (negative):	ρ
-	capital gains (Portfolio Management Department):	$\frac{\Delta p(DUR)}{p(DUR)}$
-	financing (the Treasurer's office):	$\varepsilon\phi$
		SUM = R^{NW}

The separable additive targeting function (4) is the fundamental equation for a MOSES firm. It can be divided into a short-term and a long-term component.

Short-term targets on the operating margin:

$$M = \left(1 - \frac{w}{p}\frac{1}{Q/L}\right)\alpha,$$

derived from targets on R^{NW} in (4), which in turn relate to the interest rate, guide short-term operations management of the model firm.

Past records on division profit margin performance indicate to top corporate management what has been possible to achieve in the past. A smooth, somewhat increased projection of M enters as a minimum target in top corporate negotiations with divisions for the next period. We call this observed behavior the Maintain or Improve Profitability (MIP) principle (Eliasson 1976, p. 236 ff. and p. 292). Given expected wages (w) and prices (p), division management is forced to do something about labor productivity (Q/L) to satisfy top down M requirements.

Only division management, however, knows how to increase Q/L. It keeps searching for internal solutions until the M-target is satisfied, or stops before that, if reductions in output volume lower expected profits for the next period.[5]

The long term enters through $\varepsilon\phi$ which defines returns over the going interest rate (3B). It is the critical variable in the decision to borrow that affects the cash flow available for the long-term investment decision. ϕ is the ratio between debt (borrowing = BW) and net worth (NW) and signals the financial risk exposure of the firm. It affects the local interest rate of the firm and hence ε.

Investment brings in new and better (marginal) technology which:

- increases the (potential) local labor productivity Q/L (in M)
- raises local capital productivity $Q/\bar{K}$ (embodied in α) and
- changes the mix of activities.

3.3 The Value of the Rent

The ambition of the firm is to keep its "rent" ε as high as possible over its life span. The nature of the market process is to compete rents away. Rents can arise and persist for many reasons, technical innovations and various forms of market imperfections being the most commonly quoted ones.

Schumpeter emphasized innovations. Wicksell analyzed the importance of a capital market disequilibrium (an "imperfection") in a short-term macro context. The difference between Wicksell's "real rate of interest" and "money rate of interest", when reinterpreted at the micro (firm) level, is the ε variable in (4), expressed in nominal terms. Wicksell's main concern was to explain waves of inflation, but his argument can naturally be extended to the investment decision and economic growth. The ε variable, especially if it persists with a positive or negative sign affects expectations and moves the investment decision at the firm level, as in the M-M model we use.

This leaves us with three different rent (or monopoly) generating characteristics of the economy to consider.

(1) <u>Innovative capacity</u>
treating achieved temporary market dominance as part of the concept (Schumpeter).

(2) <u>Capital market disequilibrium</u>
(in Wicksell's sense).

(3) <u>Market regime</u>
(defining the speed of adjustment of the system to marginal signals in product and labor markets).

While the first factor sets the upper limit of the capacity to produce, by way of the best combination of factors that the market process can engineer, the second factor generates the long swings of the economy by updating the production system through investment. Investment in the individual firm is stimulated by the temporary rent (= ε). Each new investment vintage is exogenously upgraded as to productivity.

The third (market regime) factor is more subtle. Departures from "static", period to period, efficiency depend on the extent to which firms do not supply the value maximizing quantities in markets each period due to mistaken sales and production plans (cyclical inefficiencies) and the extent to which labor is not allocated (each period) over firms in order of decreasing potential productivity. Each market regime will give a different momentary spread of rents that defines the structural diversity of the production system. This diversity affects both the stability of the economy and its future innovative capacity and hence the nature of the growth cycle.

4. PRODUCTIVITY, ECONOMIC GROWTH AND THE LATENT CRISIS - SIMULATION EXPERIMENTS[7]

The experiments on the M-M model presented in this paper are designed to illustrate the importance of "non-technical" factors in the growth process of an economy; factors that, nevertheless, would be reflected in total factor productivity growth measured through a macro production function technique. All experiments feature identical assumptions as to exogenous technical change at the level of new investment vintages at the division[8] level. For simplicity we refer to all other differences in specification as choice of market regime[9]. The allocation of resources across firms and over time represents an important "non-technical" part of economic growth that depends on market regime specification. Hence, all differences in economic development exhibited in the experiments refer to the choice of market regime. For practical reasons the capital market regime has been designed as one of effective interest control. Each experiment begins in 1976. The initial specification is based on 140 divisions from real firms covering some 60 percent of value added in Swedish manufacturing (Albrecht-Lindberg, 1982). The nominal interest rate is fixed at the same level for the entire fifty year period of the experiments, but at different levels in some experiments.

4.1 Market Regimes

We experiment with fast, slow and "normal" market adjustment processes. The normal market regime represents a reference case that tracks historic data well from the period 1968 through the 70s. The high speed market regime means that adjustment comes "closer to maximum static efficiency" each period (quarter). The most important adjustment parameters are to be found in the labor market. These experiments have alrady been described in Eliasson (1983). Exogenous variables (foreign prices and the interest rate) in these experiments, and innovative technical change in new investment have been designed to make new installations designed for competition in foreign markets barely profitable above the interest rate.[10] All foreign prices grow at the same exponential rate of 5 percent. Labor productivity in new investment vintages grows at 2.5 percent. Capital output ratios in new vintages are assumed constant. There is no competitive new firm entry in this model version. The results (see Exhibit 5A) suggest the existence of an optimum market regime for each set of external conditions. Through the competitive elimination of slack throughout the economy, the high speed regime is superior in macro growth terms for some 30 years, to be followed by an endogenously generated collapse around the year 2010. The economy ends up on the 50 year horizon with a smaller industrial sector (capacity) than in the normal (reference) case. The normal market regime features quite stable growth for the entire 50 year period. The slow regime also features a stable economic development, but much less output growth.

(Differences in growth rates that can be generated by respecification of market regimes (holding technology constant) are of the same order of magnitude as those that can be observed between countries for similar lengths of time (close to two percent per annum).)

4.2 Performance Distributions

Exhibits 1 show cumulative distributions of real rates of return (R) over capacity (value added).

The experiments begin in 1976 with a substantial variation in rates of return across the firm population. In all experiments the upper end of the rate of return distribution has been competed away after 50 years. The distributions in all three regimes appear to converge towards a more equal (horizontal) distribution (year 2022).

We observe from Exhibit 1B that tendencies towards such a flattening of the R distributions can be observed in Swedish manufacturing during the 70s.

The end R distributions are in fact quite close in all experiments (see further below) despite the fact that there is a pronounced difference in final output growth outcomes. (See Exhibits 5.)

We have learned from earlier experiments that the flattening of the performance distribution - firms gradually becoming more and more alike - or the establishment of "long thresholds" at fairly low rate of return levels, creates a potential instability in the model economy (see below). This indicates the importance for stable economic growth of some "innovative" factor input that preserves diversity by propping up the left hand part of the rate of return distribution.

We conjecture that this flattening of the performance distribution would not occur if new, exogenous technologies had been injected all the time through entry of new firms, or through "entrepreneurial" innovations within industrial firms.

4.3 Stability and Economic Growth

The model economy generates many stories about stability and economic growth. (They all, however, differ from the old, steady state scenarios.) Even when the simulation runs on steady state external inputs the economy exhibits long and short cyclical swings in economic development.

More significantly, there appears to be an inherent conflict between the smoothness of development and sustained economic growth. If cyclical swings are eliminated by countercyclical policy (see Microeconometrics, p. 105), or by stimulating firms to strive faster for short-term static efficiency (the fast compared to slow market regimes) thus reducing overall slack in the economy, a collapse is eventually forced on the economy, i.e. the steady growth rate breaks down (see year 32 in Exhibit 5A). The mid-term economic collapse in the high speed market regime breaks the steady convergence onto the flattened distribution of rates of return.

In the slow market regime initial rents have not yet been competed away to the same extent as in the high speed market regime. Hence a somewhat higher average rate of return for industry prevails during the entire simulation, as well as at the end of the simulation. In the long term, the slow speed market regime is associated with slower economic growth than the normal market regime. It produces a much more steady 50 year output growth trajectory than both the normal and the fast market regimes and it almost beats the fast regime on the 50 year horizon. (See Exhibit 5A.)

The experiments carried out suggest the hypothesis that a conflict exists between short-term "static efficiency" and long-term dynamic efficiency[11] and that this property relates directly to the distributional characteristics of the firm population. Diversity at the micro level is a prerequisite for stable macro growth. If you remove cyclical variations through countercyclical policies, the rate of return distributions are flattened and firms become very much alike. Minor changes in the competitive situation (generated endogenously or exogenously) can sweep a major portion of the firm population out of business very suddenly. Such changes occur frequently and unpredictably in a dynamic micro based model of the kind we are analyzing. (Fixed capital that has been competed out of business is closed down. The release of resources in the following slump, notably labor, affects factor prices and helps the recovery.) We can observe in passing that the development of the population of large Swedish firms (in the model) since 1965 exhibits a similar "collapse" of the intermediate range of the rate of return structure (see Exhibit 1B).[12]

One factor that preserves variation among firms is innovative change within firms which props up the left hand part of the R distributions.

An even stronger proposition which can be formulated on the basis of many experiments is the incompatibility between steady state macroeconomic growth and steady state growth of individual firms. Steady state macroeconomic growth has to be supported by substantial "Brownian motion" at lower levels.

A random selection of 30 out of the 150 firms operating in the model shows a significant and maintained variation in firm growth rates over the 50 year period in the normal and slow market regimes (see Exhibit 3. Distribution of growth rates for the entire population is shown in Exhibit 2.) There are no stochastic devices in the model to generate this micro growth pattern, and as the reader can observe in Exhibits 5, most macro growth trajectories are rather smooth. In the fast market regime, on the other hand, the upper end, and the tail, of the growth distribution have been competed away by the middle of the simulation. Note the heavy clustering of firms growing close to the average industry growth rate (in year 2007) just prior to the output collapse. (Almost half of the firms were growing at rates between 1 and 6 percent per annum.) Just after the collapse (the year 2012 is shown in Exhibit 2) both the growth and the rate of return distributions widened considerably.

A real firm population of some 40 financial units[13], shows (see Exhibit 4) an even stronger variation in growth rates, and in stability of production growth rates for the historic period 1965-1978. Aggregate production growth in Swedish manufacturing was faster 1965-78 than in the experiments.

4.4 Interest Rates

Earlier we emphasized the capital market disequilibrium variable; the distribution of excess rates of return over the interest rate (the epsilons). This "disequilibrium" can be generated in many ways. In our context, innovative change or new entrants to the firm population would be the most interesting ones. (Another factor would be the endogenous propagation of monetary responses to real developments through the monetary system, interest formation and investment behavior. Unfortunately, no such experiments have yet been made.)

Capital market disequilibria can, however, be exogenously introduced and manipulated through interest rate control. We have run several experiments - more or less extreme - with the interest rate variable. In these experiments we have chosen the normal market regime and rerun the experiments with nominal interest rates ranging from 3.5 percent to 12 percent.

One striking result can be noticed in the rate of return distribution. The high interest rate generates a slightly higher average rate of return to total capital employed, and an end distribution that output cake and to appropriate as much as possible of output - through the tax system and public sector growth - for redistribution. Since 1965 the first, non-interventionist part of this policy has gradually been abandoned in favor of more, and as of lately much more, central intervention in business affairs (Eliasson, 1982, Carlsson, 1983).

The fast market regime and the low interest rate cases highlight some features of the Swedish industrial policy model in stylized form.

The low interest rate policy stimulates output growth as long as the external environment is stable or predictable, as it was in the 50s and the 60s and as it is in the experimental settings of Exhibits 5.

The fast market regime, whether pushed by countercyclical policies or labor market policies aimed at increasing mobility, also stimulates a higher productivity and faster economic growth. A higher wages share (a lower profits share) is one consequence, depressing the high rate of return of fast growing firms to the left in Exhibits 1 and 2. (Also see lower part of Exhibit 5A.) The higher wage level forces low performing firms out of business, and the cumulative growth distribution in Exhibit 2 pivots to a more horizontal position. This is, however, a potentially unstable macroeconomic situation. An endogenous disturbance in the middle of the experiment is enough to generate an output collapse in the fast market regime. External disturbances of the oil-price shock type are sufficient to generate substantial and prolonged recessions in even slower market regimes, as we have demonstrated in several experimental runs.

has a slight upward tilt to the left, i.e., with relatively more high rate of return capital left and more low rate of return capacity competed out of business (exit) or deprived of funds for investment and growth. The effects are the opposite for the low interest rate regime.

However, under the external, steady state assumptions of the experiments, output growth is much faster in the low interest rate, than in the high interest rate experiment (see Exhibits 5). The reason is not necessarily that savers are fooled. If all individuals save an equal fraction of their income, they all lose an equal fraction in terms of their incomes on capital account (saving deposits), but they all get it back later together in the form of higher macro income growth.[14] The explanation is even more sophisticated than that. It has to do with the very stable, predictable external market environment introduced in all experiments so far. Even bad firms will eventually become better through borrowing and investing in capital goods of equal quality. If the competitive situation in the external market would suddenly change, however, the equal-looking, relatively low performance population of firms would suddenly be in a bad shape in its entirety.[15]

4.5 Postscript on the Swedish Industrial Policy Model

The old Swedish industrial policy model, as understood by implicit contracts (and some documents) between the unions, business and the social democratic governments, was one of non-intervention on the part of the central authority in the production process of firms, so-called solidaric wage policies - facilitating the market adjustment in the labor market - and a "low interest rate" policy. The objective was to maximize the growth of the total

Exhibit 1A Initial and terminal rate of return (R) distributions over the firm population, cumulative

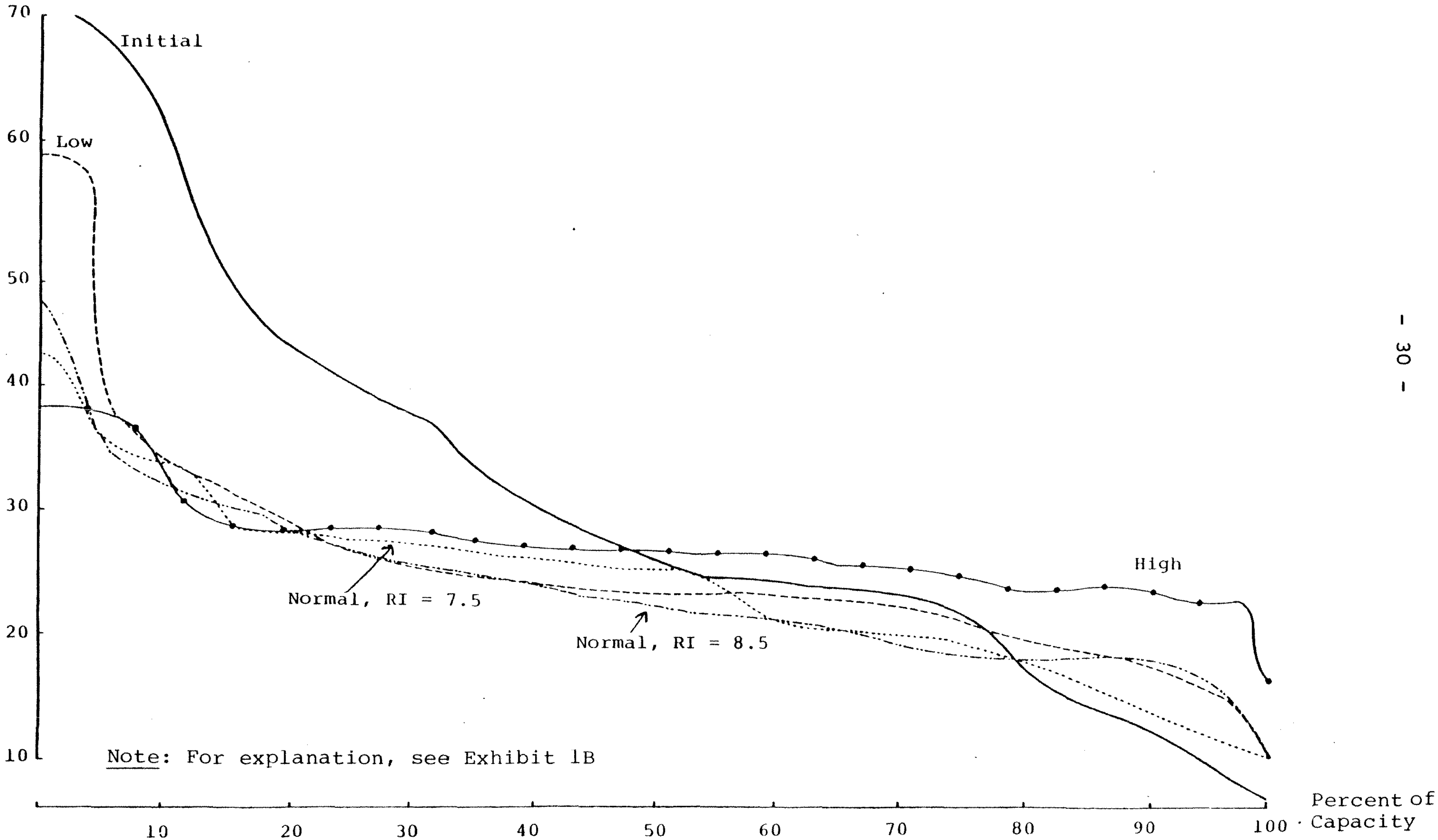
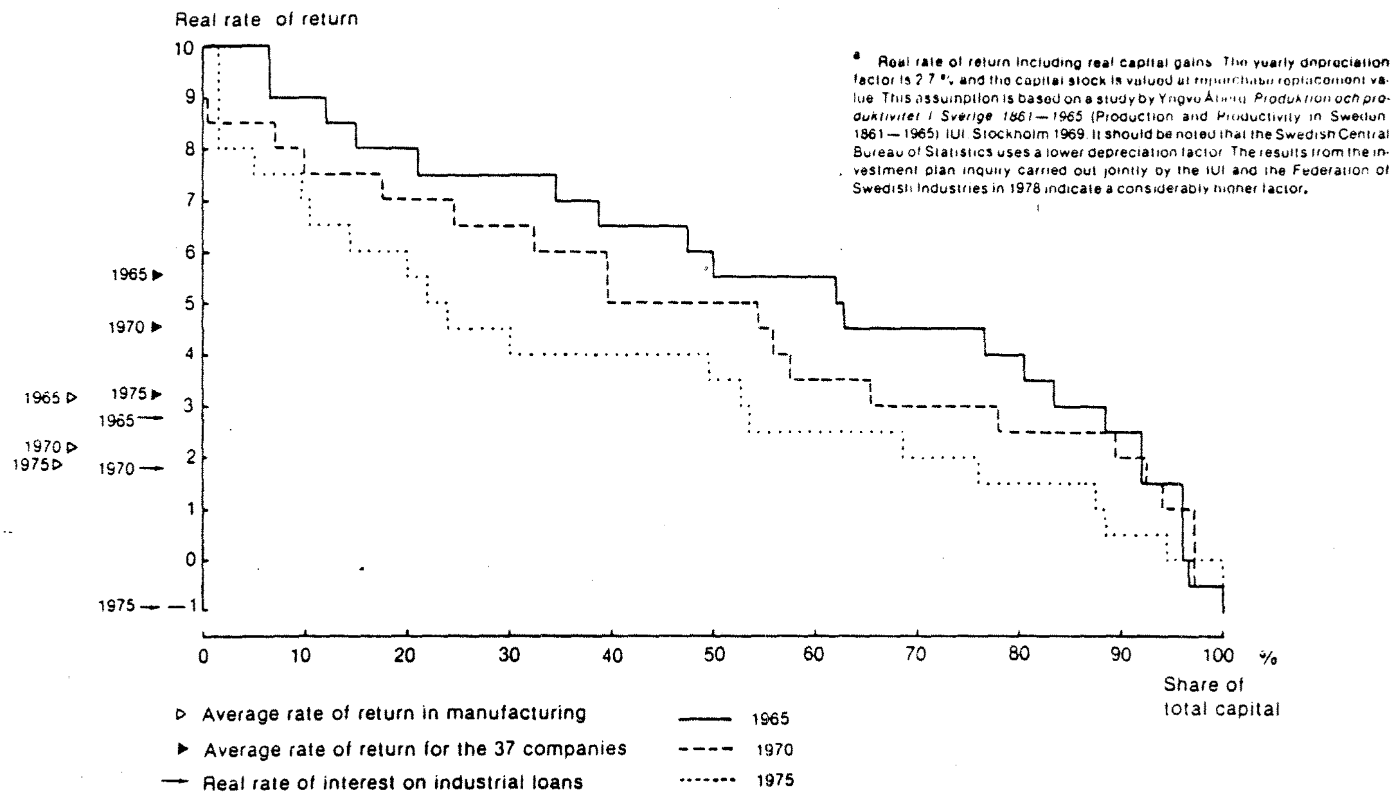


Exhibit 1B Rate of return distributions of 40 Swedish firms 1965, 1970 and 1975



Source: Thomas Lindberg, p. 69 in The Firms in the Market Economy, IUI 40 years 1939-1979.

Exhibit 2 Distribution of growth rates of entire firm populations at various points in time during simulations, cumulative (5 year moving averages)

Capacity to produce, measured by potential value added has been used as weights

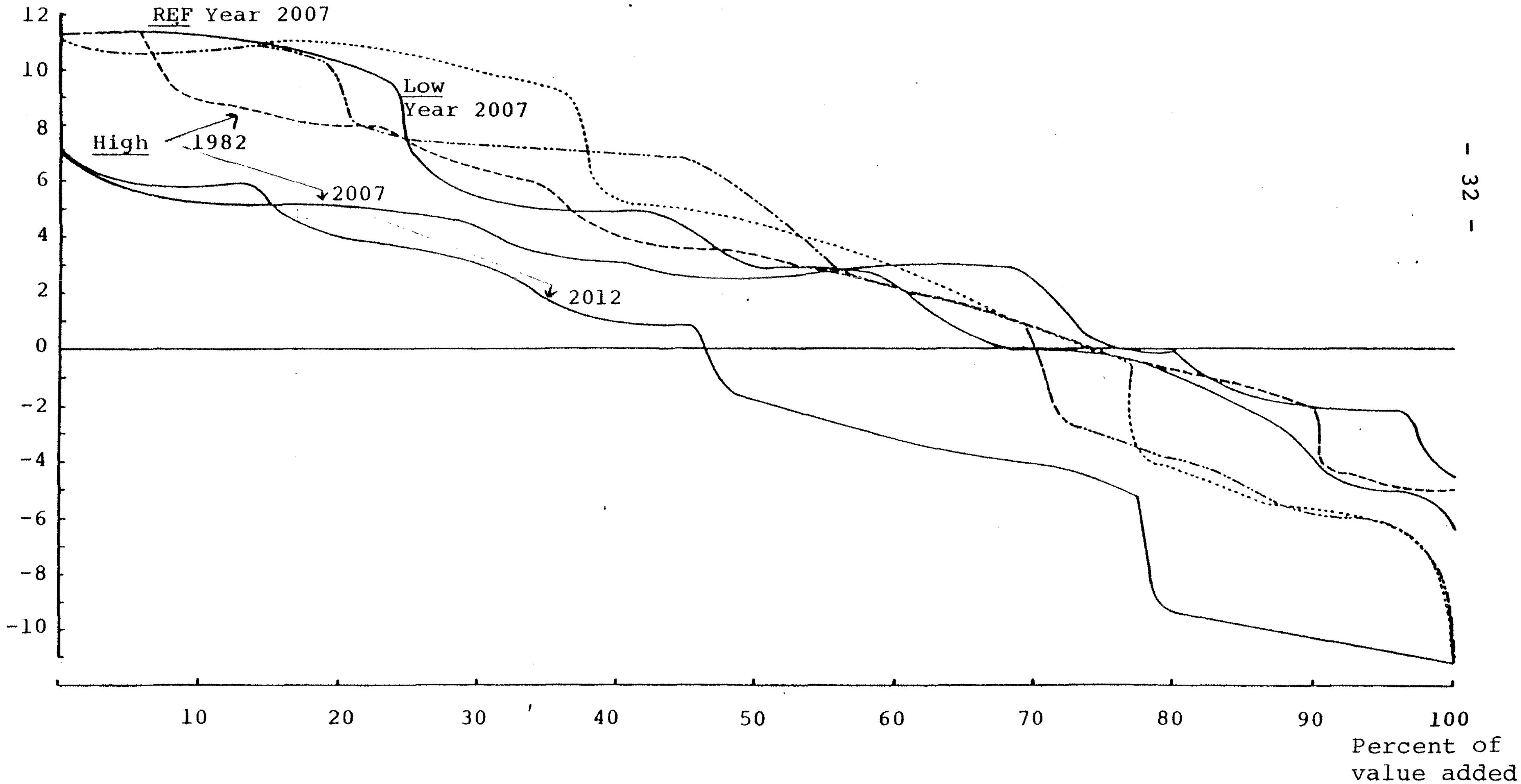


Exhibit 3 **Cumulative output growth pattern of 30 divisions selected at random, during simulation of normal market regime**

Index 1 = year 1

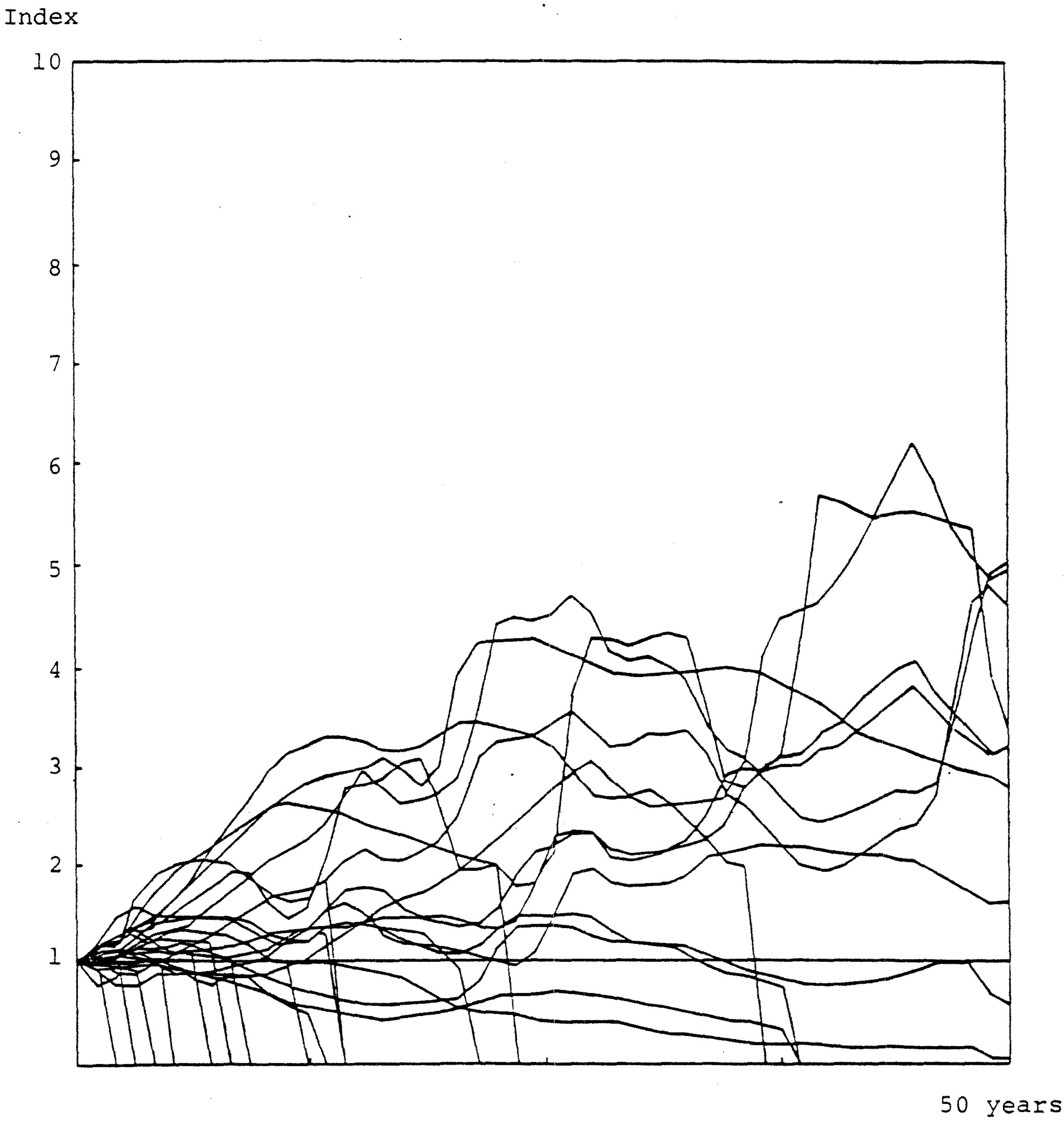


Exhibit 4 Cumulative output growth paths of the 40 largest Swedish corporations (also in M-M database) 1965-78

Index 100 = 1965

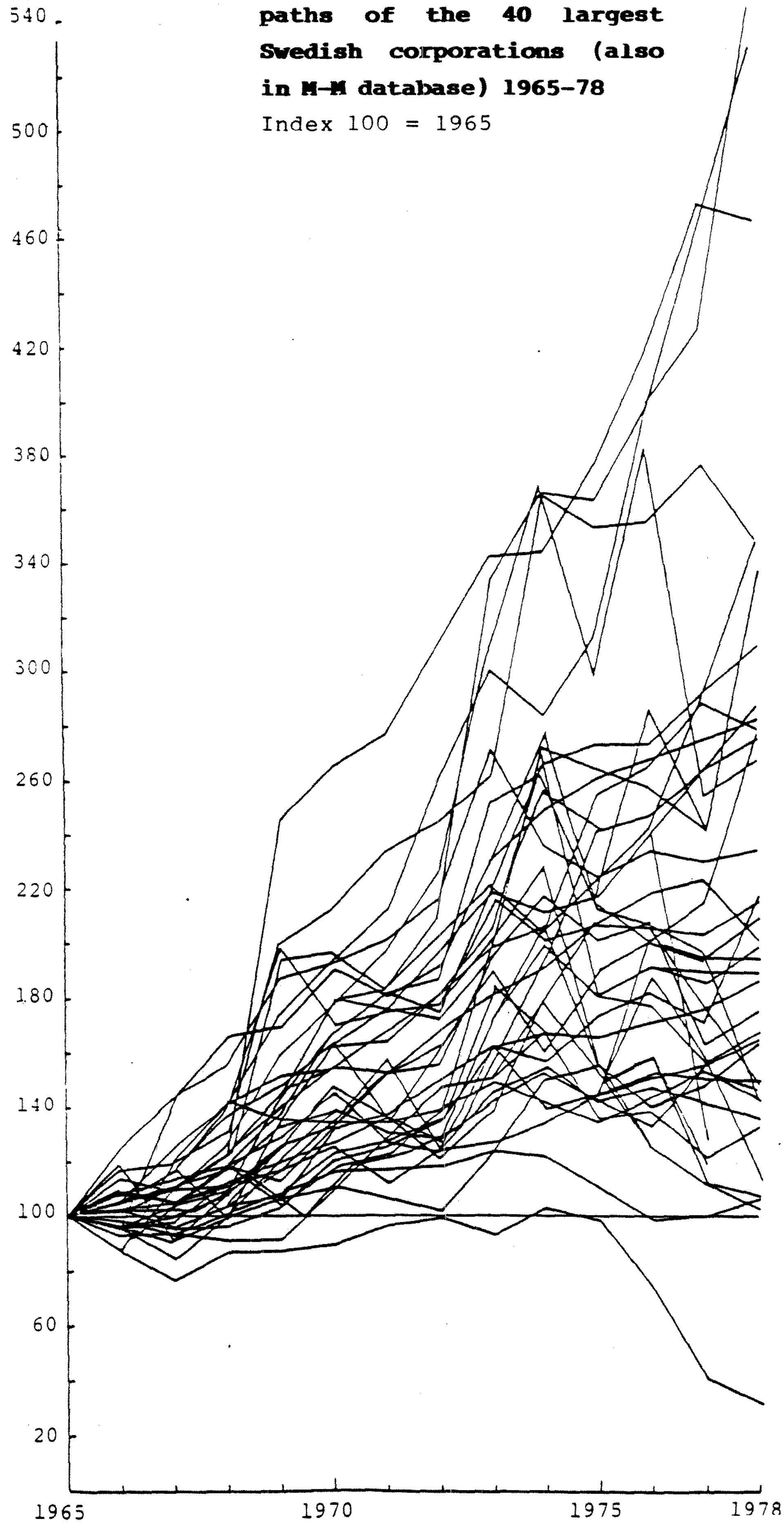
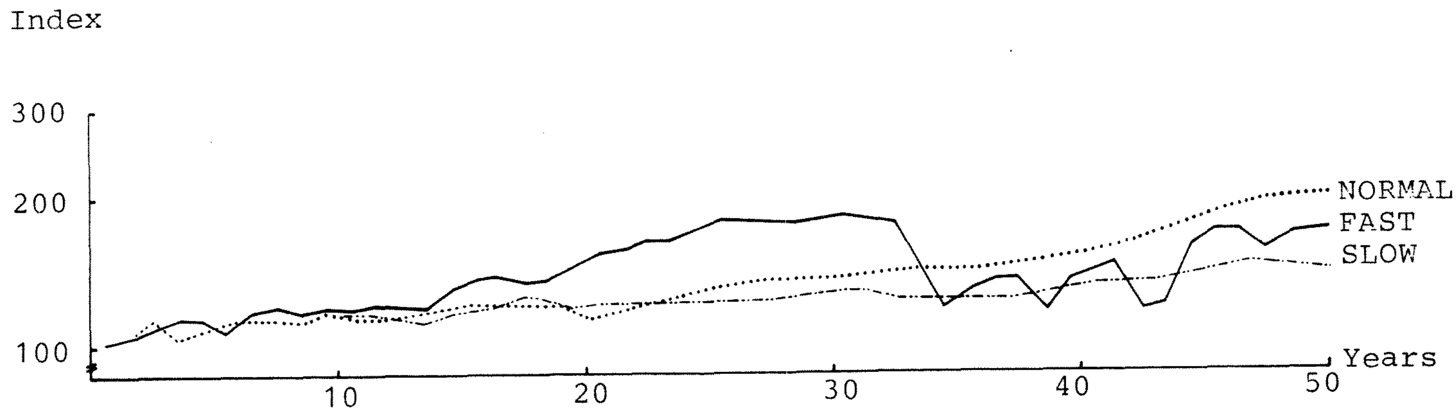


Exhibit 5A Historic 50 year simulations on M-M model, manufacturing output (cumulative) in various market regimes

Index 100 = 1976

Logaritmic scale

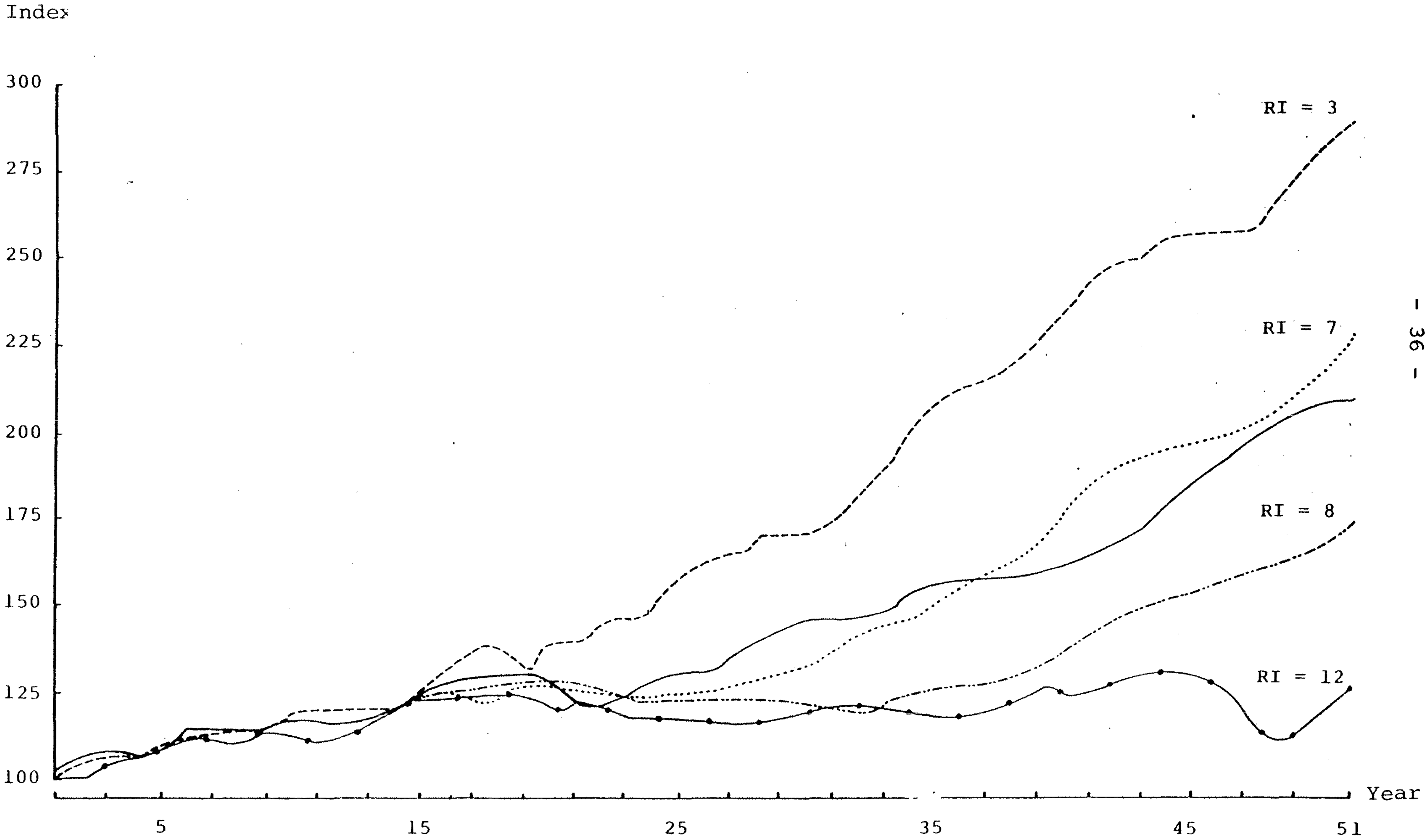


Note: Normal, Fast and Slow refer to market regimes. See Section 4.1.

Source: Eliasson (1983, p. 317).

Exhibit 5B Manufacturing output growth at various interest rates (RI)

Index 100 = year 1 (= 1976)



NOTES

[1] This scepticism rests on the quality of existing statistics. See Freeman (1982), T:son Söderström (1982), Eklund (1980).

[2] One difference, that we do not regard as important, is that L-R-S apply rules derived from optimizing behavior.

[3] (For simplicity we do not use double summation signs. It should be obvious from the text what the summation signs represent. Indices are only made explicit when needed to avoid ambiguity.)

[4] Observe that α represents the productivity of capital, or the inverse of the capital output rate.

[5] If we fix everything else in the system, including endogenous variables, this short-term price and quantity setting behavior (that has been described in detail in Eliasson (1976b, 1978)) moves the firm towards maximum next period profits. Maximization can be approximated by repeated, one period ahead, simulations for one individual firm.

[6] (This makes our analysis partial. The conceptual problem is that we have the full model and can observe what is going on in the rest of the economy. However, carrying out the full dynamic explication is impossible for didactic reasons. Hence, this conceptual simplification.)

[7] Fredrik Bergholm has been very helpful in getting the entire M-M model in good operational shape on the new 1976 database of real firms, and the new micro print-out routines in working order.

[8] The data that constitute the firm database usually correspond to the division concept. Volvo, for instance, is represented by 6 units (see Albrecht-Lindberg, 1982).

[9] This terminology may not be the best since it refers to market parameters as well as response parameters within firms.

[10] The epsilon in Equations (3) for the new investment vintage is larger than 0, but small.

[11] Or between smooth growth and sustained growth. Also cf. Klein (1977) who discusses the distinction between static and dynamic efficiency in similar terms.

[12] From database work on the model by Thomas Lindberg.

[13] They are all represented in the model by some 140 divisions. We only have divison data for the period 1975-82. These data come out of Thomas Lindberg's database analysis for the model.

[14] If household saving is very unevenly distributed across individuals (we don't know), rational savers would be fooled by such policies and eventually stop saving.

[15] This is more or less what happened to the entire basic industry sector and the shipyards in Sweden in the second half of the 70s. Cf. experiments carried out in Eliasson (1983).

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