Day, Richard A.

Working Paper
Disequilibrium Economic Dynamics: A Post-Schumpeterian Contribution

IUI Working Paper, No. 111

Provided in Cooperation with:
Research Institute of Industrial Economics (IFN), Stockholm


This Version is available at:
http://hdl.handle.net/10419/94925

Terms of use:
Documents in EconStor may be saved and copied for your personal and scholarly purposes.
You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.
If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.

Standard-Nutzungsbedingungen:
Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.
Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.
Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.
A list of Working Papers on the last pages

No. 111, 1983
Disequilibrium Economic Dynamics - A Post-Schumpeterian Contribution
by
Richard Day

Paper presented to the IUI Conference on:
The Dynamics of Decentralized (Market) Economies
Stockholm-Saltsjöbaden, Grand Hotel
August 28 - September 1, 1983

Sponsored by:
The Marcus Wallenberg Foundation for International Cooperation in Science
and organized jointly by the Industrial Institute for Economic and Social Research (IUI) and the Journal of Economic Behavior and Organization (JEBO).

This is a preliminary paper. It is intended for private circulation, and should not be quoted or referred to in publications without permission of the author. Comments are welcome.

December, 1983
DISEQUILIBRIUM ECONOMIC DYNAMICS
A POST-SCHUMPETERIAN CONTRIBUTION

by

Richard H Day

Paper presented to the IUI Conference on:

THE DYNAMICS OF DECENTRALIZED (MARKET) ECONOMIES
Stockholm-Saltsjöbaden, Grand Hotel
August 28 - September 1, 1983

Sponsored by:
THE MARCUS WALLENBERG FOUNDATION FOR INTERNATIONAL
COOPERATION IN SCIENCE
and organized jointly by the Industrial Institute for Economic and
Social Research (IUI) and the Journal of Economic Behavior and
Organization (JEBO).
Abstract

Adaptive economizing in a decentralized economy with alternative technologies and scarce resources leads to various kinds of locally unstable behavior. Economic disequilibrium is the rule in such a world and requires the presence of market mechanisms that make possible continued viability. If in addition to local instability economies are also globally unstable, as considerable evidence suggests, then the discovery and application of new structure is essential. A complete dynamic theory of economic change must therefore be based not only on conventional rationality and routinely adapting behavior but on a superior faculty which may perhaps best be called creative intelligence.
OUTLINE

1. Behavior In and Out of the Circular Flow
2. Actions
3. Transactions
4. Disequilibrium
5. Economizing
6. Local Dynamics
7. Global Dynamics
8. Entrepreneurship
9. Evolution

Epilogue
Schumpeter began his *Theory of Economic Development* with a description of the circular flow. In it each producer and consumer acts according to a best plan, the former maximizing profits (which must of necessity be zero) and the latter maximizing utilities. All actions are compatible with no room for any one to gain except at the expense of others. In short, he described the circular flow as a competitive, Pareto efficient, general equilibrium or steady state.¹

Schumpeter's dynamic analysis concerns those forces that break the circular flow and that internally generate and perpetuate fundamental change in the conditions and activities of economic life. The entrepreneur perceives the possibility of new combinations; banks create credit and place it in the control of entrepreneurs who then command the means of production from their current occupations by bidding up their prices. The temporary monopoly power of the entrepreneur enables profit to exist from which interest can be paid (which provides the source of livelihood for bankers) and which provides an incentive for additional entrepreneurial effort. The latter occurs in swarms, which leads to business cycles that are perpetuated in a more-or-less-irregular fashion. The latter characteristic complicates economizing calculations which encourages error. Such planning errors are inherent in the uncertain trial of new combinations that begin an economic boom.
These familiar elements are still of sufficient interest by themselves to command attention. Indeed, one would hope that this and other similar celebrations of Schumpeter's birth might stimulate a resurgence of interest in his work. In line with this hope I intend in the immediate pages that follow, to consider two ingredients of Schumpeter's system. The first is the behavioral content of economizing and equilibrium. The second is the assumption that economizing and equilibrium are stable in the absence of entrepreneurial activity.

On considering the first ingredient, which would now be referred to as "bounded rationality" after Simon, one is led, I think, to reject the second, that of the stability of equilibrium. In its place may be introduced components that allow for instability and disequilibrium. Although the Schumpeterian framework is substantially modified in the process we arrive at what I hope might be an improved understanding not only of how but why economies evolve and, indeed, why entrepreneurs exist.

The subtitle "A Post-Schumpeterian Contribution", indicates that addition to Schumpeter the discussion draws on subsequent literature on business cycles (including contributors of the Swedish School)\(^2\), behavioral\(^3\) and post-Keynesian\(^4\) economics (including a good share of the colleagues present at this occasion) and on my own work on adaptive economics\(^5\) and "complicated" dynamics.\(^6\) In the confines of this paper it will not be possible to trace the intellectual genealogy of all the ideas presented. I hope readers will allow me to deal with issues of lineage and association in a later work and that they will find sufficient novelty to justify inclusion of some familiar material to which they may themselves have contributed.

The central question at issue is, are economies - or human systems generally - best understood as equilibrium or as disequilibrium processes? My answer is an attempt to provide "a coherent account of the manner in which .... activities of individual economic agents are coordinated in theoretical systems that bear a family resemblance to economies of actual record" (Clower and Leijonhufvud (1975 p 183)).
1. **Behavior in and out of the circular flow**

Schumpeter described the circular flow as an intricate balancing of production and consumption activities. In it no one would have an incentive to change and agents would not need "... to find their way towards the goal of greatest possible economic welfare by conscious and rational effort". (Schumpeter 1934, p 10). The formidable logical requirements of individual optimality and inter-agent consistency would not tax the limited cognitive abilities of ordinary people or the imperfect coordinative functioning of markets. Tradition, mere habit, or inertia would be enough to keep economic actors in line with their own best interests.

Schumpeter elaborates this behavioral theme repeatedly and at some length. I think he did so because it was essential to his assumption of stability. First of all there is the question, if agents cannot calculate the steady state from scratch how do they contrive to stay in such a state once there? Why don't they jump or wander away? Second, there is the even more important question, if the conditions for a general equilibrium have not been attained, how can agents who are unable to calculate their optimal equilibrium states conspire to bring about an equilibrium position with the passage of time?

To Schumpeter the answer to both questions was that practical behavior had a stabilizing character. He cited several reasons. (i) Agents inherit an inventory of means and methods of production that are the basis of current activity. (op cit p 6). (ii) The past influences the activity of the individual because it has "taught him what to do." (ibid). (iii) One will cling tightly to habitual economic methods and only submit to the pressure of circumstances as it becomes necessary. (op cit p 8). (iv) The individual is never equally conscious of all parts of the value system..... also he does not pay attention to all the facts but only to certain indexes "ready to hand". (v) He acts in "the ordinary daily round according to general custom or experience." (op cit p 40).
Evidently, to Schumpeter, it is the tendency to cling to the familiar, to resist change, to adapt only slowly under pressure that keeps adaptive agents at equilibrium within the circular flow. (op cit p 235). Moreover, this presumed "stability" is indispensable for the economic conduct of individuals. Without it the limited economizing of which they are capable is rendered extremely difficult. He continues:

This empirical way of acting has a rational basis. There is one kind of economic conduct which, under given conditions, establishes the equilibrium between means on hand and wants to be satisfied in the best way possible. The value system ... cannot be altered .... without the individual's having the experience that he is worse off than before ... therefore ... one and only one way of acting commends itself to the individual, and the results of action remain the same as long as the given conditions remain the same. (op cit p 40).

Schumpeter argued that all this applies to steady growth as well for it does not involve essential change or difficult choice but only stable repetition of established activity. Thus, Schumpeter is precise: General Equilibrium Theory characterizes the rational content of an equilibrium or steady state; the adaptive nature of people explains its perpetuation once entered.8

He also thought that this adaptive nature adequately described the "economic system's tendency towards an equilibrium position" (op cit p 62). This tendency "may be described as an adaptation to data existing at any time". (ibid). The data of course may change, either gradually, in which case no change in the equilibrium story is necessary, or drastically, in which case stable adjustment will occur bringing about a "new equilibrium position". (op cit p 62-63). But, in contrast to the quite elaborate defense of the various other points of his argument, here he merely postulates a "noteworthy stability" in the absence of any creative agent. As long as agents in their roles as consumers, workers and managers have only given "data" to which to adapt, the circular flow emerges.
Given this assumption of stability new forces must be introduced to disrupt equilibrium once it is attained, ones that do not function in the circular flow. These disequilibrating forces are mediated by the two new agents who augment the preexisting population of consumers and firms. These agents are entrepreneurs and banks. The former perceives (or creates) new combinations of the materials and forces of production while the latter creates purchasing power and places it in the hands of the former, thus enabling entrepreneurs to effect the pursuit of expected profit which without credit would be impossible.

The introduction of these "new" agents raises two further questions whose answers are essential for a complete theory of development. First, why, if we begin within a circular flow, should entrepreneurs and banks exist? And second, if entrepreneurial activity exhibits swarms and perpetuates a business cycle so that the circular flow is never attained, then how is the economy able to function in disequilibrium when agents make mistakes and when supply does not equal demand.

In order to answer these questions we have, I think, to reexamine Schumpeter's case for the stability of the circular flow. As a prerequisite we have, however, first to take a close look at the actions and interactions of agents.
2. Actions

An economy consists of a population of individuals who are organized into a variety of groups, such as firms and households. Following well established convention I will refer to such groups as well as individual persons as agents. Production and consumption activities pursued by agents are coordinated in a variety of ways, within centralized organizations by systems of budget, valuation and allocation messages and rules, and between individuals and organizations by means of price adjustments and exchange.

Organizations must construct plans through a series of exchanges up and down a hierarchy in an essentially dynamic process that includes data collection, storing and processing activities. Current and past performance indexes are prepared. Current external conditions are estimated and forecasted. Plans of a more or less elaborate nature are drawn up. While all this is going on actions must take place in fact; resources must be allocated in fact; food must be produced and consumed in fact. Therefore, while actions may be influenced by existing plans they have to be controlled by various mechanisms which are also determined by current operating conditions, which themselves may not be accurately or correctly anticipated in existing plans or in the new plans being formed. This control system must operate in real time and must be distinct from planning itself. An organization's behavior is therefore determined by an Information - Planning - Control (IPC) system. Individual behavior may be thought of appropriately also as determined by an IPC system but with a mental-physiological structure of specialized functions rather than a socio-economic one.
All coordination among agents must take place through the operation and interaction of IPC systems. Ostensibly, in equilibrium, plans will be realized, estimates will not change; the control system need only keep behavior from wandering or jumping. Ostensibly, also, information will correctly determine not only where data and performance indexes are but where they will be in the future. If one wants to characterize the rationale for the equilibrium no harm is done by ignoring or suppressing the distinct information and control subsystems and substituting for them an assumption of perfect forecasting ability as is done by some of the more extreme members of the neoclassical school.

In disequilibrium, however, expectations are not fulfilled. Individuals and groups do not and cannot know what everyone is doing or what they will do in the future. They must observe, construct a record or image of the past which is of necessity simplified and imperfect. They must base plans on data that may prove biased, wrong or misleading. They must construct controls that enable economic activity to continue when even the most carefully constructed and elaborated plans must be modified in the light of accumulating information or because they simply can't be carried out. If one wants to explain how and under what conditions an equilibrium circular flow emerges or fails to emerge one must take account of these fundamental facts.

3. Transactions

Transactions among agents are mutually interrelated actions involving the exchange of information and goods and the establishment or modification of constraints on further action. How do transactions occur? According to the classical/neoclassical economic theory upon which Schumpeter builds, they occur - in the circular flow - according to competitive equilibrium prices. These constitute the "partial" information indexes upon which equilibrium plans can be based by practical agents.
But the equilibrium prices are determined implicitly on markets that are not fully described by Schumpeter or subsequent contribution to the theory of exchange.\textsuperscript{10} To the extent that markets are dealt with at all they are represented as auctions or bidding games, or as bargaining procedures such as those that govern real estate or the formulation of wage contracts. Markets governed by Bidding-Negotiation-Bargaining processes of these first two types are reflected in the abstract idea of the "auctioneer" or "helmsman" and constitute the Hicksian "flex-price" mechanisms that are modelled in stability analyses of general equilibrium. For our purposes here it is important to recognize that the stability of flex-price adjustments rests on highly restrictive assumptions and even the most prominent contributors to the theory have never been satisfied with it.\textsuperscript{11}

A glance at the real world reveals two widely used market mechanisms in addition to auction and bargaining procedures. Most evident on the retail scene are stores. Stores are essentially inventories on display with Information-Processing-Control procedures that focus on inventory adjustment and price determination.

Almost as evident and perhaps even more important are order-delivery information systems that govern most wholesale, construction and heavy investment transactions. Individuals and organizations order goods. Producers, warehouses and stores receive orders and either fill them or delay delivery, adjusting their order backlog accordingly. Even the stock market, which is often thought of as an example of a competitive market, works in part on the basis of order-delivery information system with broker-specialist agents.

From a physical point of view these second two market types are stock-flow mechanisms that mediate transactions among agents using periodic price-adjustment rules. They are the prototypes of Hicks' fix-price markets. To emphasize the role of inventories and orders in such markets I will refer to them as Inventory-Order-Price-Adjustment processes.
No doubt the specific character of the commodities involved, such as their storability, their time period of production or their relative cost, influence or determine what type of market mechanism is used in transactions involving them. But a noteworthy fact is that Bargaining-Negotiation-Bidding processes are not pervasive in the real world. Moreover, one could imagine an economy that uses Inventory-Order-Price Adjustment procedures exclusively. Their basic virtue is that they facilitate exchange when supply and demand are not equated at prevailing prices. Or to put it into the terms of the Information-Planning-Control framework, they enable production and consumption actions to occur when consumption and production plans are inconsistent.

4. Disequilibrium

All of the transaction types outlined can and sometimes are carried out within a single organization, usually by means of a decentralized subunit (agent) that specializes in that function. Importantly, however, independent agents also exist who mediate transactions. Stores mediate transactions through inventories on display. Catalog orders and sales agents and brokers mediate order/delivery exchange mechanisms. Banks and other financial intermediaries govern the exchange of money and credit while negotiators, arbitrators, lawyers and courts mediate the bargaining processes. These must be added to the "auctioneer" and to firms and households as the fundamental economic agents of economy. The questions we now need to consider are (1) Would these agents exist in equilibrium? (2) If not, why do they exist?

As we noted above, Schumpeter gave what has become the standard answer (Debreu, Arrow-Hahn) to the first of these questions. It is, "No". In equilibrium, plans become actions that are optimal given prevailing equilibrium prices. No distinction between plans and actions need be made. Moreover, as a best action is taken on the basis of current data no agent will modify his behavior if similar data are repeated. The commodity flows implied by ac-
tion are perfectly coordinated. Stocks remain constant or change at a constant rate and play no fundamental role. A greatly simplified structure results, one that has only producers and consumers. But in reality marketing agents exist and so do entrepreneurs. Why? This is the question begged by Schumpeter's dependence on an equilibrium description of the circular flow. An answer to it can be contemplated if we agree that if practice agents cannot compute optimal actions and equilibrium transactions, then it is appropriate to consider initial condition in disequilibrium.

Consider the process leading to action. Its information and planning elements take time, are costly and subject to error. The more "rational" in terms of careful observation, elaborate data processing and sophisticated analysis, the more time and resources it takes. But actions must occur more or less continuously. These must be feasible for the economy to work. Out of equilibrium they need not and very often will not correspond to plans. Changing action will lead to changing data to which agents will adapt their plans but these can only be formulated imperfectly and with a lag. By what means can such agents be sure to converge to equilibrium? Even if they did, as long as they did not - which could be a very long time - mechanisms that allowed the agents to function in the meantime would have to exist.

Or consider the nature of transactions. Bargaining especially takes time, lots of time. Try to imagine a real world where all transactions are directly negotiated. Is it possible that such a world would not breakdown? To reduce transaction costs to manageable levels market mechanisms would have to be introduced that do not explicitly require negotiation and bargaining. They would have to allow production, consumption and exchange to occur when plans are immediately impracticable and while excruciatingly slow Negotiating-Bargaining processes are at work.

To summarize: economies work only because actions are governed by principles in addition to rationality and the theoretical existence
of equilibrium prices. These principles include (1) the separation of information, planning and control activities in economizing behavior and (2) the existence of explicit Inventory-Order-Price-Adjustment mechanisms that mediate transactions in disequilibrium. Each agent controls a stock of resources that are required by his information processing, planning, and controlling activities. These activities involve consumption, production and exchange that diminish some and augment other stocks. Agents' must determine actions and transactions compatible with feasible stock-flow relationships. They are aided in this task by the existence of exchange mechanisms based on Inventory-Order-Price-Adjustment procedures.

Since equilibrium prices cannot govern behavior out of equilibrium, explicit price adjustment rules must emerge. They must be constructed in such a way that actions can take place more or less continuously even though current prices transmit more or less erroneous information and must themselves be adjusted according to unfolding information.

If transactions between agents at a given time can not be perfectly coordinated except perhaps by the miraculous direction of some unseen hand then how much less plausible is the possible coordination of transactions involving future, anticipated actions. Banks' abilities to create credit introduced an extremely flexible medium allowing the supply and demand for purchasing power to differ and for its excess demand or supply to fluctuate indefinitely. Historically, as economies became more and more complicated, the gradual evolution of credit instruments became a primary means - not of bringing about equilibrium - but for allowing economies to work at all. An economy that has evolved banks in order to sustain disequilibria is of course preadapted for the Schumpeterian entrepreneurial/credit expansion process! Nonetheless, the origin of banks must be bound up with the need to provide for intertemporal exchanges out of equilibrium.
5. **Economizing**

The neoclassical theory of economic rationality and of general equilibrium was invested with a behavioral content by Marshall who recognized that economic calculation was often an incremental process that took place "at the margin" in response to utility, profit or quasi-rent differentials, and by Walras whose Tatone-ment was supposed to represent in an abstract way price-quantity "groping". As is well known, however, this behavioral content was not sufficient to define a theory of behavior out of equilibrium. Instead it was interpreted as a prerequisite to exchange which took place after the assumed emergence of equilibrium prices. Hence it did not require the definition of action-transaction mechanisms of the kinds elaborated above. Schumpeter fully accepted this interpretation in basing the stability of economizing and equilibrium on behavioral principles.

This behavioral rationale for the Walrasian equilibrium paradigm contrasts in an interesting way with another well known contemporary point of view based on continuous market clearing and "rational expectations" in which information is optimally utilized, the economy is driven by external stochastic shocks - which do not prevent continuous equilibration - and in which agents know the relevant probability distributions. In this theory rationality, supply-demand consistency, and social efficiency are used not only to characterize steady states but also to explain irregular business fluctuations. Although wisely motivated and ingeniously developed I do not think it provides a sufficient understanding of how economies work -- for the reasons that have concerned us up to this point and that are to be further developed below. I shall therefore return to a consideration of economizing from a behavioral point of view in the context of economic disequilibrium.
In practice, economizing must proceed by intuitable or computable steps. These are usually extremely simple relative to the overall problem of choice under consideration. The mathematical analog of economizing behavior is the optimizing algorithm that decomposes the choice problem into a sequence of simple calculations and binary comparisons that are applied iteratively. These iterative steps are usually nested within a sequence of approximations to the "true" optimizing problem at hand.

These optimizing algorithms converge to a "true" optimum only for a relatively small class of problems that have very strong but not very realistic regularity conditions. It is fundamentally for this reason that in real life economizing activity is focused on relatively simple, relatively stable choice situations that usually solve only a part of the problem of deciding what to do. Other behavioral rules must fill in the huge gap that is left between what is to be explained and what is well explained by explicit economizing calculations.

Economizing behavior is, therefore, conditioned in two ways. First, it applies to only a part of the variables over which individuals and organizations have control. Second, it proceeds according to forms that are approximate, relatively simple and iteratively applied. Because of these two characteristics, models of economizing behavior are distinctly different than the definition of an optimizing problem or than the specification of the sufficient conditions for optimality upon which orthodox theory builds.

A specific model of economizing behavior reflecting this point of view can be based on a frequently encountered principle of algorithm construction which is the incorporation of more or less ad hoc rules that limit the distance succeeding steps take in a sequence of trial choices. This is the analog of the principal of local search that forms a part of the core of adaptive or behavioral economics. When explicitly represented in a mathematical model of economizing behavior it leads to a sequence of recursively connected mathematical programs, each of whose constraints
depend on solutions of programs earlier in the sequence and which define what I have called elsewhere "zones of flexible response" (ZFR's) within which local rationality is exercised. This representation of behavior might be called "local optimizing" or "suboptimizing with feedback".16

In one particular form of this approach the zone of flexible response is defined to be a region centered on past experience which allows departures from the preceding choice to a greater or lesser extent that also depend on experience. In illustrating the idea I have used fixed maximal and minimal percentage changes from preceding actions ("flexibility coefficients") to govern current choices. While such a model may not capture all the characteristics of real world economizing, I think it is a plausible if not compelling candidate for a first approximation. It has a property in some experimental model economy settings that illustrates a broader principle crucial to the subsequent discussion. Such economizing simulated in a competitive market environment on the computer does not converge to a stationary state but rather to a bounded set containing the stationary state and within which oscillations are perpetuated (Day 1979). Using a principle of increasing caution in response to failure, convergence to a stationary state within this framework could, however, be achieved.

Suppose all agents did in fact behave in this way and so behavior did converge. Such stationary states might only be local optima with better candidates at some remove. Moreover, if data changed from time to time due to "external" forces such "optimal" equilibria could be less effective than would be suboptimal behavior that failed to converge to a stationary state. Indeed, because no one understands completely how the world works, no one fully comprehends the problems whose optimal solution we want to find. Therefore, one cannot be sure that when an algorithm for solving a perceived problem emerges one has converged to the solution of the real problem at hand. This suggests that optimum seeking behavior should not allow a succession of market punish-
ments gradually to discourage search to the point where it disappears entirely. Rather there should be continuing unmotivated search in an environment that may be "irregular" or subject to drift or perturbation, or when local search in response to feedback can get "stuck" in locally good, but globally suboptimal decisions. Such search can be driven by curiosity, eccentricity or "playfulness" but not economic calculation of the usual kind. Evidently, the whole idea of an equilibrium is fundamentally incompatible with wise behavior in an unfathomable world.

Another class of procedures for irregular (nonlinear, non-convex) optimization problems has been developed in which at each step a local random search is made; then an approximate choice-response function is estimated and optimized. An early example was Box's evolutionary operations procedure (EVOP) for minimizing production costs for highly nonlinear (and not completely understood) chemical processes. An important point is that a rational solution is attained through local search in which random behavior plays an essential role. Ironically, it is in the constructed rational solution process that randomness is introduced.

6. **Local Dynamics**

So we have found in models of bounded rationality a reason why an economy might continue to wander, never settling down to an equilibrium. And we have found in constructive models of rational choice a reason for randomized behavior. Such "irregularities" would provide a source of continuing perturbation that would bring about an escape from any economic equilibrium accidentally entered. The implication is that even in an economy where a hypothetical equilibrium existed the behavioral mechanisms that govern it might not possess a corresponding stationary state. And even if such a state did exist it might not be locally stable so that the slightest perturbation might disrupt it. In either case appropriate disequilibrium mediating mechanisms would have to be present for the economy to work.
Now set aside these sources of local instability. Set aside also any exogenous source of stochastic shock to the economy. There are at least two additional reasons for considering the local instability of economic equilibria.

New theoretical research suggest that purely deterministic economies need not converge but may wander in a completely nonperiodic, random like fashion because of nonlinear relationships in technical structure or behavioral rules. This "chaotic" phenomenon has been shown to arise naturally in economic models, even within widely known and accepted or standard economic theories. The possible sources of non-linear feedback in economic processes are many and include among others a sufficient intertemporal substitutability condition in overlapping generation models, nonlinear experience dependence of preferences, sufficiently strong induced investment demand in the standard Keynes IS-LM model and the existence of financial (working capital) constraints in models of the firm.17

In a chaotic world, no amount of time series information about the past could enable one to forecast with any accuracy the future course of economic data essential for long run rational planning. Moreover, the tiniest error in the estimate of any parameter or initial condition leads to rapidly growing prediction error - even if all functional forms are perfectly known!

It is noteworthy that in the first of the above examples, chaotic intertemporal, competitive equilibrium trajectories are shown to exist. Consequently, it should be clear that we are not dealing with artifacts of adaptive economizing or disequilibrium processes. Of course, the possibility of deterministically generated pseudo-randomness for some parameter values of a mathematical model does not establish the existence of the phenomenon in the real world. It does show, however, that economies contain relationships that can provide an endogenous explanation of the observed irregularity of economic variables. Such endogenously generat-
ed irregularity does involve instability including the possibility of
local instability of conventional economic stationary or steady
states.

Still an another important source of instability in the economy
is that of endogenous phase switching. The technical processes of
production provide alternative means for transforming materials
and energy into commodities, these in turn are constrained by re-
source availabilities. In an essentially linear world such as envisio-
ned by von Neuman a steady-state growth path may exist that in-
volves an unchanging menu of production/consumption processes.
However, if constraints from unproducible and exhaustible resour-
ces are introduced then the course of development must lead to
a change in the relative supplies of resources and produced capi-
tal. These changes in the relative limitativeness of constraints
will also bring about a change in imputed values similar to those
that occur when technological change introduces new production
processes into the choice set, with the result that the economy
as a whole and individuals or organizations in particular are "trig-
gered" on to different paths characterized by essentially different
equation structures.

This process of multiple phase dynamics, which is a characteris-
tic property of recursive programming models of economic
change, provides an endogenous explanation of structural change
that does not rest on the existence of entrepreneurs but merely
on conventional economizing in the presence of unbalanced devel-
opment. It says that given techno-economic regimes may be un-
stable; that such regimes may switch with the passage of time.
Irreversible switching may be called structural development. Expe-
rience with models incorporating multiple technologies suggest
that oscillations among regimes in a periodic or even in a more-
or-less random fashion can occur but that under some conditions
of resources availability or of preference or demand irreversible
switching of a kind mimicing technological evolution charac-
terizes model behavior. 18
7. **Global Dynamics**

We now have a basis intrinsic to the structure of economic action and transaction for rejecting the idea that stationary equilibria exist - or even if they exist that they are locally stable. This means that disequilibrium mechanisms are necessary for the existence of an economy. That is, if an economy is to work at all and keep on working at least for a while it must possess specific structures that allow actions to occur when the conditions of economic equilibrium do not prevail. It also means that entrepreneurs are not needed to explain the disruption of equilibrium or even the progression among technological-behavioral regimes where the latter resemble certain of the stages of development that characterize part of what are observe in the evolving real economy.

Does this also mean that disequilibrium mechanisms, properly specified, are also sufficient for continuous economic viability without the presence of entrepreneurs?

If the answer were "yes", then we would have shown that economies were **globally stable**, which means that they would neither expand in some kind of boundless explosion, or contract until they break their bounds of definition. They would continue to work without innovation even if, due to changing resource availabilities, ordinary economizing led to a kind of progressive structural change.

If the answer is "no", there is a reason intrinsic to the economy itself for entrepreneurs to exist, a fundamental reason why there should be a source of wholly new combinations of material and activity that ultimately replace the system already in place.

I began to consider the possibility that global instability of economies had to be considered after years of accumulating experience with simulating models that were designed to represent adaptive
economizing behavior in hypothetical, representative firms, empirical agricultural regions and industrial sectors. Sometimes these models would exhibit growth with bounded but eventually expanding oscillations with an eventual but quite sudden transition to inviability. Very often the source of breakdown was in the financial feedback relationships linking sales, revenue, production costs, credit/debt transactions, and the supply of working capital. Eventually, after considerable experimentation, stabilizing parameter changes could be found, but these did not always have a compelling basis in the empirical data.

A common reaction to such simulation experiences is to reject the models as unrealistic, to keep tampering with them until they behave in a more stable manner. I now believe this kind of reaction is based on an unwarranted presumption that real economies are approximately stable, a view which is based on the observation that economic variables often exhibit proximate stability for extended periods of time. Such "finite span viability" is not ultimately reassuring to those who find themselves close to the end of the span.

Possibly the presumption of stability is also based on the mistaken belief that only for stable processes can meaningful, analytical theory be developed. However, one can imagine analytical proofs in our field analogous to those in some others, of finite "escape", i.e., that trajectories of economic variables must escape, after a definite period of time, some bounded set that defines viability. I do not have such proofs for any of the models whose simulations suggest their relevance. This is a task for future theoretical work that will be necessary to buttress inference based on computational example.

Here I want to stress other sources of evidence: direct experience and the historical and archeological record.

There is, of course, no question that great civilizations disappear, that once flourishing technologies decline and cease to be used,
that important institutions give way to others based on new forms of organization and different rules of conduct, that once common strategies are abandoned in favor of new ways of planning what to do and new rules for controlling what is done.

We know that in the course of such developments parts of an economy stop working not merely because they are voluntarily abandoned but because they break down. While the grand forces that led to the decline and fall of past empires can only be conjectured on the basis of incomplete historical data or scanty prehistoric artifacts the more common breakdowns of contemporary economic life are sometimes chronicled in considerable detail in the daily press and in the transcripts of court and regulatory agency proceedings. In the midst of the present recession, for example, we read of financial crises in firms and banks on the brink of insolvency and of bankruptcy proceedings for institutions that have already gone under. In a dynamic microeconomic model the state variables representing the character of such organizations would have passed outside the limits consistent with the definition of viable behavior. If such a model were simulated, the computer would usually be instructed to print "no feasible solution".

Even at the macro level comparable breakdowns occur. Think of the U.S. banking system in 1933 when the "bank holiday" was declared. In this case not just a single bank but the entire system stopped working. In the process the old system was destroyed and a new one set in motion. Are we to think of this merely as a switch between two pre-existing regimes? Are we to think in general of the switch between a given population of agents and their rules of behaviour and the successor population where an old agent as such has disappeared or a new one has emerged - are we to think of this transition in general either as an analytical switch in regime or as a change in population?
No doubt as theorists dedicated to the development of analytical model of understanding we will want to pursue these possibilities as far as we can. But it seems to me that in doing so we are unlikely to explain those features of economic change which we experience as its most human quality, namely, the ability of individuals to conceive new combinations and of groups to form unanticipated solutions to temporarily unresolved conflicts.

8. Entrepreneurship

...And so we come to entrepreneurs, for they are the ones in the arena of human getting and spending that create new combinations from which the forms of economic activity and organization evolve. In a globally unstable economic world their specific existence is a necessary condition for economic existence in general. Out of the population of ideas they create are selected ones that lead to forms that prevent collapse, or that reshape a system so that it takes off on a new spiral of development.

The existence of entrepreneurs must no doubt be explained by the forces of biological and social evolution that explain human development generally. Certainly it is related to the emergence of creative intelligence - I distinguish this from rationality - that has led to the origin, proliferation and growing sophistication of human culture. Once creative intelligence exists the possibility of inventing economic structure exists.

Schumpeter taught us much of what we need to know about the nature of entrepreneurs but he did not explain why they intruded themselves on the circular flow. One possible explanation is now clear. They do not intrude on the circular flow; they emerge in a disequilibrium, globally unstable economy with the fundamental function of creating the mechanisms that allow an economy to work when its agents are boundedly rational, its transactions imperfectly coordinated, and its long run behavior intrinsically and globally unstable.
Thus, they are both the result of and the mediator of evolution both in its narrow biological sense and in its broader cultural sense. Once a part of human culture their activity does not switch on and off according to well-defined accounting messages or in response to carefully anticipated need. It functions more or less continuously thereby providing a continuous source of perturbation to the analytical structures that define routine production, consumption and managerial activity. The implication is that economies will evolve whether they need to or not. Schumpeter's theory of cycles tells us something about how that evolution can occur.

9. Evolution

Economies, like other aspects of nature and human existence, evolve. They have histories that are described, not just in terms of the trajectories of their states, but also in terms of the genesis of structures that define their flows. To some extent, as we have seen, the genesis of structure can be represented as a progressive switching of phases in a world where multiple potential regimes exist. Adaptive economizing in disequilibrium leads to such endogenous structural change and would be a sufficient theoretical construct to explain evolution if real economic systems were globally stable.

If it is supposed that they are not globally stable then models that can be globally unstable are relevant candidates for analyzing economic change. But they force us to augment our inventory of theoretical concepts because a given globally unstable system can describe a historical process for only a finite period of time.

One approach is to develop an evolutionary theory of variation and selection for a population of economic organizations or rules, as is done by Nelson and Winter in their several contributions
and by Eliasson in his Micro-to-Macro Model of the Swedish National Economy. Such theoretical construct describes the transition of a population with a given set of characteristics to a new population with different characteristics. If in such a theory individual agents or behavioral structures are allowed to breakdown, go bankrupt, die, or otherwise disappear, then we have a theory that again provides an analytical characterization of what is from the individual agent's point of view an inviable system, but one in which the population of agents may exist indefinitely. If the state variables of the theory characterize the relevant population - as opposed to the constituent individual agents or rules - then it is possible for the analytical, evolutionary model to constitute a dynamical description of a population with viable behavior.

In the transition from the dynamics of individual behavior to the dynamics of population characteristics, however, the boundaries separating the living from the dead and the yet unborn is passed over. Do we know any analytical representation of what happens in these shaded domains where things that once were no longer are, where somehow something new emerges which was not there before? It was Schumpeter's special contribution to have seen, and seeing to have insisted that another force, beyond economic rationality and beyond routine adaptive behavior was responsible for the surge of economic development from form to form.

He did not really describe that force, which I think is best described as creative intelligence, but rather its mediator in the economic realm, the entrepreneur.

We know that the states which characterize essential properties for individual living organisms eventually escape their realms of definition. Nature has been able to extend life not by creating eternally viable organisms but by the forces of reproduction so that populations of individuals have a much extended history. The growing record of the past however, assures us that most species
that have ever existed have perished and that many of those now in existence are also rapidly perishing as well. Again we see the dynamics of inviable systems working even at this higher level of organization.

In human affairs the story seems to be the same at every level. As Schumpeter perceived, it is the entrepreneur who is partly responsible for he is the one who introduces the new combinations that lead to the eventual abandonment of existing activity. More fundamentally, however, if the theory presented here is correct, the entrepreneur, even in his most extreme achievements, exists not as an agent who disrupts a system that without him would settle down to a repetitive existence of indefinite duration. Instead he spans the dialectical penumbra between a system that without him would selfdestruct and a new system that can grow and flourish, if not forever, then for some span of time. Thus, his destruction is creative and to the intelligence he exercises is owed the continuing existence of a mundane realm within which rational choice and economic exchange can function.
The author is Professor of Economics and Director of the Modelling Research Group at the University of Southern California.

The final version of this paper was prepared at the Industrial Institute for Economic and Social Research, Stockholm, Sweden for delivery at the Conference on the Dynamics of Decentralized Market Economies, August 29-31, 1983.

1. In this paper "a competitive equilibrium" is defined in the usual way as a state in which individual optimality and inter-agent consistency prevail; I define "economic disequilibrium" to be a state in which one or both of these properties do not hold. A "stationary state" is a state of rest in which the state variables describing the economic system do not change; A "steady state" is one in which all variables are changing in the same proportion ("balanced growth"). Stationary or steady states can only be defined for a complete dynamic model that describes the laws of change for the system. The concept of a competitive equilibrium as defined above can (and typically is) used to describe a static model where the laws of change are not specified. For Schumpeter, who was explicitly concerned with dynamics, the "circular flow" was a stationary or steady state that was also a competitive equilibrium.

2. Much of the business cycle literature of the 30s through 50s has a distinct behavioral character. As examples I think of Kalecki (1935), Metzler (1941) and Goodwin (1955) just to mention a few. The "Stockholm School" focussed on the essence of the problem. The seminal works include Myrdal (1939), Lundberg (1937) and Lindahl (1939). For a review see Bjorn A. Hansson (1982).

3. The behavioral literature is surprisingly large (if scattered). Seminal contributions include Simon (1948, 1955), March and Simon (1958), Cyert and March (1963), Forrester (1961, 1966), Kornai (1971), Winter (1964), Nelson and Winter (1975, 1982) and Eliasson (1976). Space does not permit more than these few samples. A brief survey of the field will be found in Day (1982).


7. In the parlance of dynamical systems theory Schumpeter was asking first, does the dynamic system of behavior possess a stationary or steady state; and second, (if so) is it stable? Roughly speaking, "local stability" means the ability of a system to approach a stationary or steady state arbitrarily closely if the initial conditions are sufficiently close to begin with. A locally unstable system will move away from such states no matter how close they may initially be.

8. In this paper "adaptive behavior" is defined to be behavior that responds to states of the system (effectively or not). Thus, farsighted economic behavior is adaptive if the data anticipated for the future upon which current behavior is based depend only on current and past information about the economic system.

9. The distinction between planning and control is not unrelated to Kornai's distinction between "Real" and "Control" spheres of an economic system. Here, however, information, planning and control are separate functions within Kornai's "control sphere" required by disequilibrium in the real sphere. See Kornai, pp. 39-42. I draw directly on Day (1975) who distinguishes between "transitor" and "adaptor" which would appear to be the same as Kornai's breakdown. This idea seems to underly the flexible accelerator and goal adaptive adjustment processes of Simon and Simon and March and of Forrester's distinction between "absolute management goal" and "negative feedback" adjustment rule.

10. In both Debreu (1959) and Arrow and Hahn (1971) the term "market" does appear but markets are not described. Debreu does devote a chapter to a careful description of commodities and prices. Thus, while the theory of competitive general equilibrium may rationalize an equilibrium system of transactions and constitutes an equilibrium theory of price, it is not a theory of markets.

11. That individual bargaining need not lead to supply-demand equilibria was a possibility illustrated by Chamberlain (1957) in what was probably the first experimental market.

12. The point is made especially clearly in Arrow and Hahn who assert that "... the distinction between stock and flow equilibrium (is) relevant only in the analysis of what, in our definition, are disequilibrium situations". Arrow and Hahn (1971 p. 50).

13. Of course, the business cycle literature, for example Metzler (1941), encompassed the role of inventories in the economy and in particular dealt with why inventory replacement demand tended to keep the economy away from equilibrium. I do not know that the point made here, however, has been
recognized unless it would be in the industrial dynamics approach of Forrester (1961). Kalecki might have had the principle in mind in his dynamic model of capitalism. Certainly he recognized the role of order-backlogs but like most Marxians he was so interested in the instability of markets that he overlooked their more fundamental role in mediating disequilibria.

14. Contrast this view with the "monetarist position" that it is the existence of money which allows equilibrium to exist. If we define economic equilibrium conventionally (see note 1) money would not be necessary in it. One can hardly imagine disequilibrium without it. Borrowing (waiting to pay) must have accompanied the emergence of exchange even in the most primitive economies of early man.

15. See Lucas (1979) for the classic statement and appropriate collateral references.

16. The idea of such behavioral constraints in an explicit optimizing framework was introduced by Wood (1951) and was the basis of an ingenious behavioral programming model actually used to forecast U.S. Agricultural production on a regional basis by James M Henderson (1958). I explored the dynamic implications of Henderson's model and incorporated similar relationships in a more general recursive programming model in 1963, an early exposition of which relating it to Schumpeterian ideas was published in 1959. Attempts to develop the idea more generally followed in 1970 and 1977.


18. See Day and Cigno (1978) for examples. For a summary of the implications, see Day (1982).

19. See note 17.
REFERENCES


Hahn, F., 1973, "On the Notion of Equilibrium in Economics".


WORKING PAPERS (Missing numbers indicate publication elsewhere)

1976

1. Corporate and Personal Taxation and the Growing Firm
by Ulf Jakobsson

8. Estimation and Analysis with a WDI Production Function
by Göran Eriksson, Ulf Jakobsson and Leif Jansson

1977

15. Pay Differentials between Government and Private Sector
Employees in Sweden
by Siv Gustafsson

1980

25. On Unexplained Price Differences
by Bo Axell

34. Imperfect Information Equilibrium, Existence, Configuration
and Stability
by Bo Axell

1981

36. Energi, stabilitet och tillväxt i svensk ekonomi (Energy,
Stability and Growth in the Swedish Economy)
by Bengt-Christer Ysander

38. Utility in Local Government Budgeting
by Bengt-Christer Ysander

40. Wage Earners Funds and Rational Expectations
by Bo Axell

42. The Structure of the ISAC Model
by Leif Jansson, Tomas Nordström and Bengt-Christer
Ysander

43. An Econometric Model of Local Government and Budgeting
by Bengt-Christer Ysander

44. Local Authorities, Economic Stability and the Efficiency of
Fiscal Policy
by Tomas Nordström and Bengt-Christer Ysander

45. Growth, Exit and Entry of Firms
by Göran Eriksson

Shares Analysis
by Eva Christina Horwitz
56. Central Control of the Local Government Sector in Sweden
by Richard Murray

59. Longitudinal Lessons from the Panel Study of Income
Dynamics
by Greg J. Duncan and James N. Morgan

1982

61. Var står den nationalekonomiska centralteorin idag?
av Bo Axell

63. General Search Market Equilibrium
by James W. Albrecht and Bo Axell
General Equilibrium without an Auctioneer
by James W. Albrecht, Bo Axell and Harald Lang

64. The Structure and Working of the ISAC Model
by Leif Jansson, Thomas Nordström and Bengt-Christer
Ysander

65. Comparative Advantage and Development Policy Twenty
Years Later
by Anne O. Krueger

67. Computable Multi-Country Models of Production
and Trade
by James M. Henderson

69. Relative Competitiveness of Foreign Subsidiary Operations
of a Multinational Company 1962-77
by Anders Grufman

71. Technology, Pricing and Investment in Telecommunications
by Tomas Pousette

72. The Micro Initialization of MOSES
by James W Albrecht and Thomas Lindberg

75. The MOSES Manual
by Fredrik Bergholm

76. Differential Patterns of Unemployment in Sweden
by Linda Leighton and Siv Gustafsson

77. Household Market and a Nonmarket Activities (HUS)
- A Pilot Study
by Anders Klevmarken
1983

79. Energy Prices, Industrial Structure and Choice of Technology; An International Comparison with Special Emphasis on the Cement Industry by Bo Carlsson

81. ELIAS - A Model of Multisectoral Economic Growth in a Small Open Economy by Lars Bergman

84. Monopoly and Allocative Efficiency with Stochastic Demand by Tomas Pousette

86. The Micro (Firm) Foundations of Industrial Policy by Gunnar Eliasson

87. Excessive Government Spending in the U.S.: Facts and Theories by Edward M. Gramlich

88. Control of Local Authority Expenditure - The Use of Cash Limits by Noel Hepworth

89. Fiscal Containment and Local Government Finance in the U.K. by Peter Jackson

90. Fiscal Limitations: An Assessment of the U.S. Experience by Wallace E. Oates

91. Pricing and Privatization of Public Services by George E. Peterson

94. Job Mobility and Wage Growth: A Study of Selection Rules and Rewards by Bertil Holmlund

96. The Machine Tool Industry - Problems and Prospects in an International Perspective by Bo Carlsson

97. The Development and Use of Machine Tools in Historical Perspective by Bo Carlsson

99. An Equilibrium Model of Search Unemployment by James W. Albrecht and Bo Axell

100. Quit Behavior under Imperfect Information: Searching, Moving, Learning by Bertil Holmlund and Harald Lang
102. Collecting Data for Micro Analysis, Experiences from the Hus-Pilot Study by N. Anders Klevmarken

103. The Swedish Micro-to-Macro Model - Idea, Design and Application by Gunnar Eliasson


106. Public Policy Evaluation in Sweden by Bengt-Christer Ysander


109. Capitalist Organization and Nationalistic Response; Social Dynamics in Age of Schumpeter by William Parker

110. A Nonwalrasian Model of the Business Cycle by J.-P. Benassy

111. Disequilibrium Economic Dynamics - A Post-Schumpeterian Contribution by Richard Day

112. Schumpeterian Competition in Alternative Technological Regimes by Sidney Winter

113. The Industrial Finance Systems; Europe, U.S. and Japan by Tad Rybczynski

114. The Microeconomics of Organization and Productivity Change - The Use of Machine Tools in Manufacturing by Bo Carlsson

115. On the Behavioral and Rational Foundations of Economic Theory by Herbert Simon

116. Schumpeterian Dynamics by Erik Dahmén

117. Micro Heterogeneity of Firms and the Stability of Industrial Growth by Gunnar Eliasson

118. The Initialization Process - The Moses Manual, Part 2 by Fredrik Bergholm