

A SCHUMPETERIAN HETEROGENEOUS AGENT MODEL OF THE BUSINESS CYCLE

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SCHUMPETER'S MARKET PROCESS THEORY OF THE BUSINESS CYCLE

Schumpeter's business cycle theory is rooted in chapter 6 of the *Theory of Economic Development: An Inquiry into Profits, Capital, Credit, Interest, and the Business Cycle* which he published in 1911.¹ This book, which laid the foundations for Schumpeter's scientific work, did not become famous because of its explanation of the trade cycle. Instead, it was Schumpeter's analysis of the market process that was regarded as the most important part of the *Theory*. The point of departure was the traditional notion of an equilibrium economy with goods and money moving in a constant circular flow. Because all of the resources were allocated to their optimal utilization, there was no economic reason to depart from the familiar path. For equilibrium theorists, changes of a given setting could only be triggered by disturbances originating from non-economic events such as wars or natural catastrophes which alter the scarcity conditions of the economy. This would affect relative prices which would force the agents to adapt their plans to the new situation. Once the disturbance had been digested, the economy would assume another stationary state, which would be a stable one because nobody would have a reason to depart from it (Schumpeter 1949b, chap. 1).

The problem with this equilibrium notion was that it was not consistent with economic reality. There was no circular flow continuously reproducing itself, and there were not only passive adaptations to exogenous changes of relative prices, but active competition among industrial corporations which introduced new products and new production processes. To include this form of dynamics into economic theory, Schumpeter introduced the concept of the "pioneering entrepreneur," who breaks away from the equilibrium flow by generating "new combinations" (chap. 2). However, since the equilibrium of an economy is a state in which by definition all assets are employed, neither investment money nor production

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¹The subsequent exposition is based on a tight selection of Schumpeter's voluminous publications on business cycles which total about 2,500 pages. For a comprehensive evaluation of Schumpeter's work see Oakley (1990). The number of pages was counted by Tichy (1985, p. 3).

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inputs are readily available to the pioneer. Therefore, the pioneer needs support from the banker who creates credit money. This money can be used to extract physical resources from the circular flow by offering higher prices to the suppliers (Schumpeter 1949b, chap. 3).

On the one hand, this procedure creates credit inflation. On the other hand, it enables the pioneer to start a new business. When he finally opens up a new market by offering a new product, he is a monopolist who can charge prices above costs. He starts earning profits from which he starts paying back his credit. The pioneer's profits signal lucrative investment opportunities to potential competitors who enter the market by imitating the pioneer's innovation. This increases supply, exerts pressure on prices, and brings profits down accordingly. The process continues until the innovation has spread across the market, profits have been competed away, and repayment of loans has been completed. Finally, the economy reaches a new equilibrium state in which all of the agents have adapted their plans to the new situation (*ibid.*, chaps. 4 and 5).

By comparison to the literature of his time, which attributed the causes of economic unrest to economically inexplicable exogenous disturbances, Schumpeter's theory of the pioneering entrepreneur provided substantive theoretical progress because it modified equilibrium theory by integrating the trigger of economic dynamics. But, the argument presented so far relates only to a single product market. To trace the economic fluctuations of the whole economy back to this elementary source of market dynamics, several additional steps have to be made. The most important one relates to the timing of pioneering moves. If innovation events occurred randomly, distributed over the entire economy, their disturbance effects would not have the potential of generating up- and downswings of the whole economy, because they would average out. In order to gain enough strength to affect macroeconomic totals, the innovation-imitation events have to be synchronized. Schumpeter offers a set of different economic arguments as to why innovations should occur in a swarmlike fashion. First, once the equilibrium has been disturbed by the pioneers, others may follow more easily, because the level of difficulty is lower if the circular flow has been broken already. Thus, primary innovations always induce a much larger number of secondary follow-up actions. Second, the economic and technological effects of innovations are not restricted to the immediate industry that has been affected in the beginning. Instead, they may spread across related industries as well, which in turn are compelled to react. Third, consumption expenditures of employees, whose income has been financed by credit expansion, affect consumption goods industries. Further, reliable calculations of innovative investments can only be made in equilibrium, when economic parameters are known, which requires them to be constant. This is not the case while innovation-imitation processes are going on. Therefore, entrepreneurs having pioneering ideas during a disequilibrium phase of the economy have to wait until a new equilibrium is established before they can break out again (*ibid.*, chap. 6).

This is the essence of the first version of Schumpeter's business cycle theory that was published in 1911. It was elaborated afterwards in a set of follow-up publications. In 1935, Schumpeter worked out the role of equilibrium in his theory. First, he explicitly specified the circular flow to be a Walrasian equilibrium in which each firm and each household are in equilibrium. Second, he laid particular emphasis on the

theoretical necessity to start reasoning from a fictitious equilibrium point in order to avoid circularity. Third, he set up the “three-cycle-scheme” which was based on a classification of the innovations according to their economic thrust for generating waves of different lengths. It was made up of Kondratieff waves, Juglar waves, and Kitchin waves having durations of 60 years, 10 years, and 4 years, respectively (Schumpeter 1935).

By 1939, the theory had matured and was published in coherent form in a two-volume treatise (Schumpeter 1939).² It included the graphical representation of the three-cycle-scheme which had become famous because it explained the Great Depression as the combined result of three coinciding downswings (Schumpeter 1964, p. 175). The largest part of *Business Cycles* was made up of empirical examinations of American, British, and German time-series on various aspects of cyclical and long-run phenomena, some of which went back as far as 1787 (ibid., chaps. 6–25). Until now, Schumpeter’s work has been the second largest empirical examination of the trade cycle. It is exceeded only by the voluminous studies by Burns and Mitchell (1946) which were made at about the same time at the National Bureau of Economic Research (NBER). The uniqueness of Schumpeter’s work lies in the attention he paid to the history of industries, the behavior of entrepreneurs, and the emergence of new industries, which are not examined by Burns and Mitchell.³

Theoretical Problems and Empirical Drawbacks

Critics have pointed to several theoretical problems and empirical drawbacks of the treatise. It was argued that the distinction between innovators and imitators exaggerated the case because the latter faced similar obstacles and were also required to have a vision about commercially useful projects. It has been suggested that the unreal stereotypes of the innovator and the imitator be replaced by distinguishing “primary innovators” and “derivative innovators” (Redlich 1955). Further, critics asked why such an outstanding person as the pioneering entrepreneur is supposed to wait until imitators have competed his profits away; he should have both the capability and the means of staying ahead of his rivals by continually producing innovations. The regularity of business cycles called for the rhythmical emergence of pioneering moves which was not guaranteed by Schumpeter’s equilibrium-state argument (Kuznets 1940). First, the idea that reliable calculations were possible only in equilibrium was countered by pointing out that planning of investment projects does not require the complete price list for the whole economy, but is based only on prices for the necessary input factors. Thus, actual information needs are much smaller and can be met at any point in time (Tichy 1984). Second, since finding buyers for a new product is always risky, there is no systematic reason why the risk of introducing an innovation should be higher out of equilibrium (Rothbarth 1942; Tichy 1984). To the contrary, once aggregate profits have started to rise, the very fact that profits can be made is an incentive for competitive moves. Further, the decline of profits during the slump is also a stimulus for change (Rothbarth 1942).

²An abridged version was published by Fels in 1964 (Schumpeter 1964).

³See Schumpeter (1939, chaps. 6, 7, and 14) for many examples of technical innovations from a wide range of industries.

Another group of objections was raised against the Kondratieff–Juglar–Kitchin scheme. It was pointed out that there was no necessary connection between the scheme and the theoretical model (Kuznets 1940; Marschak 1940). One objection was that the notion of equilibrium which plays an essential role for the working of the model gets obscured, because the superimposition of three different waves yields eighteen different types of equilibrium. This is due to the fact that points of rest for shorter waves are located on points of unrest of the longer waves. The theoretical consequences of this are not mentioned in the treatise (Tichy 1984). Another objection was that the regularity of each wave's movement requires the underlying innovations to be of similar economic thrust. But, there is no theoretical reason given in the treatise for why this should be the case (Kuznets 1940). Further, it was emphasized that Schumpeter's voluminous empirical analysis did not provide much support for his theory (ibid.; Lange 1941; Marschak 1940; Rothbarth 1942). He did not present any mathematical decomposition of historical time-series from waves of different types, but merely recorded his own visual impressions of the charts. His failure to follow the articulated methods of time-series analysis, which had just been developed, was strongly criticized (Kuznets 1940). As a consequence, Schumpeter was not been able to verify his assertion of fixed size-proportion for the three waves (Marschak 1940). The only observation which seemed beyond doubt was his demonstration of the Kondratieff waves. But while his critics accepted this to be a historical fact, they pointed out that there had been no satisfactory theory as to why such long swings should recur as a result of an underlying economic mechanism.

An Outline for a Research Program

Focusing only on the deficiencies does not do justice to Schumpeter's work, for Schumpeter himself did not consider his approach to be a complete theory. To the contrary, Schumpeter never tired of stressing that his approach was only an outline for a research program that had to be filled in by followup studies. For instance, in 1933 he criticized the then current practice of the newly founded business-cycle research institutes to focus on aggregative analyses only. Looking at macroeconomic totals was not helpful for the purpose at hand, because aggregates not only blurred historical details but might even provide a wrong picture. Instead, Schumpeter (1933, pp. 265–66) encouraged detailed examinations of the history of industries, which should include single firm studies as well as innovation histories.

Further, Schumpeter (p. 266) warned of the uncritical transference to economics of mathematical methods that were not made for this purpose. He suggested that new mathematical methods be developed instead.⁴ Two years later, he described a complete research program, which included detailed examinations of the technical, economic and historical features of the development of modern industries to find out more about the influence of internal and external factors on the shape of the cyclical process. Once again, Schumpeter (1935, pp. 8–9) stressed the importance of the study of single firms, because each firm was an individual "resonator."

⁴In the same year, the Econometric Society was founded with Schumpeter as one of its founding members. For the theme of its journal *Econometrica*, which included a strong focus on business cycle theory, see Frisch (1933, pp. 1–4).

The strength of the critique raised against the three-cycle-scheme appears to be unjustified, if not even superficial. It does not strike at the heart of Schumpeter's approach because he never declared it to be an economic law. He frequently pointed out that his intention in setting up the scheme was to get a working hypothesis about the economic impacts of innovations on which the empirical research of Kondratieff, Juglar, Kitchin and others differed. Schumpeter (1935, p. 7) never insisted on three different innovation cycles. He had chosen this number simply for practical purposes to simplify the exposition of the theory. Schumpeter (1961, p. 180) plainly admitted that he had not been able to prove the existence of the Kitchin waves, because he did not have the means for a thorough examination. In the preface of the *Business Cycles*, Schumpeter (p. 5) invited his readers to do their own research for which his work could provide nothing more than the springboard.⁵

After publication of *Business Cycles*, Schumpeter continued to stress the advantages that might arise from cooperation between economic historians and theoreticians. He went on publishing essays which were in fact nothing else but outlines for interdisciplinary research programs on the business cycle. For instance, he suggested a classification system for firm-level phenomena. He conducted excellent studies that should be elaborated upon (Schumpeter 1947a, pp. 153–54). He identified issues and problems in order to shape the research process (Schumpeter 1947b, p. 9). He suggested inquiries into the financing of innovations by equity and loans, and the role that the banks played in this process (Schumpeter 1949a, pp. 78–79). Many of his proposals were illustrated by examples from traditional economic theory, which he thought to be irrelevant because they had no grounding in the real world. Again and again, he pointed out the need to examine how individual firms rise and fall and how this dynamic affects the aggregate indicators of an economy (Schumpeter 1947a,b; 1949b; 1951).

But all of his suggestions for future work went unnoticed. One reason was that Schumpeter's theory offered no help for the solution of the economic problems of his time while the theory of Keynes was tailor-made for this purpose. Both its relevance for economic policy and its theoretical compactness explain the victorious advance of Keynesian macroeconomics after World War II. Also, empirical research had not been able to demonstrate the existence of innovation swarms. This was considered to be a refutation of the theory. In today's textbooks on business cycles, Schumpeter's theory is presented only for reasons of completeness or is missing altogether.

Most surprisingly, the Schumpeterian renaissance triggered numerous studies of innovations, firm behavior, and market dynamics, without considering their implications for the advancement of business-cycle theory.⁶ Thus, substantive

⁵The term "springboard" is used only in the preface to the German edition.

⁶A convenient way to get an overview of the typical issues of the rapidly growing literature of the Schumpeter renaissance is provided by the conference volumes of the Schumpeter Society and by its journal, *The Journal of Evolutionary Economics*. A typical feature of this literature is that it is strongly dominated by industrial economists, whereas macroeconomic issues play only a minor role. Business-cycle theorists have not joined the Schumpeterian community because the current mainstream of neoclassical real business cycle theory is incompatible with Schumpeterian ideas. Thus, the artificial separation of economics into microeconomics and macroeconomics against which Schumpeter fought all his life continues to prevail.

attempts to improve Schumpeter's market-process based explanation of industrial fluctuations are still missing. The present article attempts to resurrect this part of Schumpeter's research program. The following section collects evidence from recent research relevant to the purpose at hand. Particular attention will be paid to findings on the economic heterogeneities of the firm and how this relates to the business cycle. Section 3 then presents a formal model that tries to capture the heterogeneity of the agents by employing spread measures, a new class of variable that has not been used in formal business-cycle theory before. In conclusion, it will be argued that the model employs Schumpeter's strategy of disaggregate explanation without being open to the criticisms that have been raised against Schumpeter's approach.

COLLECTING SCATTERED EMPIRICAL EVIDENCE

In the present section, three bodies of literature will be examined in order to collect empirical evidence on the functioning of the market process, which might be of use for Schumpeter's explanation of the business cycle. The first body of literature concerns the innovation problem which has been examined from three different perspectives. The first one is the industrial economic perspective. Industrial economics came into being as a separate branch of economics in the 1950s by doing research into the structure-performance relationship. This approach rested on the implicit assumption that industry market structures were exogenous. In the meantime, scholars have realized that the structure of a market is an endogenous variable that changes systematically over time. From this perspective, the innovation issue is relevant insofar as it determines the development of the market structure via the rates of entry, survival, growth, and exit of firms.⁷

The second is research on innovation having its roots in business economics and relates to a wide range of issues centering around marketing policy, reasons for achieving and maintaining market leadership, and the composition of profitable product portfolios. And, the third is research on innovations and stands strongly in the Schumpeterian tradition. It emerged as a coherent body in 1984 when the newly founded Schumpeter Society held the first of a series of semi-annual meetings. The literature of the Schumpeterian renaissance combines the two previously mentioned research paths into a consistent theoretical framework. It has encouraged a great deal of work on the measurement and diffusion of innovations, and their impact on the economic performance of firms, industries, and countries.⁸

Taken in its entirety, the innovation literature has provided important insights into the working of the competitive process. It has been found that markets pass through different developmental stages as they evolve over time. In the birth phase of a market when a new product has been commercially introduced, considerable experimentation takes place to improve the characteristics of the product. Quite frequently, there is more than one early mover in the market because different firms pursue similar ideas. Entry rates are high because the lead of the incumbents

⁷See, for example, Klepper and Simons (1997), Utterback and Suarez (1993), Klepper and Graddy (1990), Gort and Klepper (1982) and the references cited therein.

⁸See, for example, the conference proceedings of the Schumpeter Society meetings, Hanusch (1988), Heertje and Perlman (1990), Scherer and Perlman (1992), Shionoya and Perlman (1994), Helmstädtter and Perlman (1996), and Eliasson et al. (1998).

is not wide and entry barriers are low. As the product matures and the dominant design emerges, the nature of competition changes from product-related to process-related innovations. The compulsion to do so arises from within the market, because once the product meets customers' needs, demand rises rapidly and production has to be increased accordingly.

In the expansionary stage of the market, competition for the better product gradually changes to competition for the lower price, which is both an incentive and a force to shift innovative effort to the production sphere. Suppliers who are not able to compete leave the market. As the number of competitors decreases, price competition stiffens because growth of the incumbents facilitates large-scale production techniques which have the side-effect of functioning as entry barriers. These impede imitative entry by smaller rivals and the market matures to an oligopolistic structure. But this does not necessarily mean that the dynamics of competition fade away in the sense of an approximation to an equilibrium, because entry barriers can be circumvented by product differentiation which alters the markets' boundaries.

By comparison to Schumpeter's time, knowledge of the working of the market process has sharpened substantially. Innovation is not a single outstanding event occurring only at discrete times. Instead, it is an ongoing process affecting products as well as production techniques with an endogenously driven shift of focus toward process innovations. Firms cannot take the liberty of stopping innovation because this runs the risk of falling behind. Further, incumbents cannot prevent their rivals from competing because entry barriers can be sidestepped by product differentiation. Thus, there are both forces and stimuli effective at all times rendering the market process an incessant sequence of competitive moves and counter-moves.

What is still missing is the linkage between this industrial-economic research on the dynamics of single markets and the dynamics of the macroeconomic business cycle. But there is not much reason to proceed on the track Schumpeter laid, because innovation research has not provided any clues for the clustering of different primary waves at the same points in time. Neither has there been any evidence for the repeated occurrence of similar wavelengths. Diffusion times have been found to be idiosyncratic properties of the respective markets, depending on peculiar characteristics that are impossible to combine into wave-bundles affecting the whole economy. The shortest diffusion times that have been reliably identified amount to about ten years, suggesting the economy oscillates much slower than it actually does. Innovation research has also found that the economic lifespan of products is competed down in a similar way as prices are forced to decline. This, in turn, would imply an acceleration of industrial fluctuations, which has not been observed.

One may conclude from all this that Schumpeter's explanatory approach does not work, because it has been shown to be not in accordance with the facts. But this would be a hasty judgment. The macroeconomy does fluctuate and this phenomenon is the combined outcome of all businesses in all markets of the economy. Another result might be to say that Schumpeter's idea of bundling innovation waves according to their frequencies and points of inflection is not an appropriate solution to the aggregation problem. Instead, one might examine firms which are nothing else than bundles of market operations, according to another aggregation

criterion. This might provide another view on the emergence of the business cycle which is still within the frame of Schumpeter's research program. Today, there is not much literature on the cyclical biographies of firms and how their varieties fluctuate, but a few studies exist.

The oldest reference of which the author is aware is a paper by Hultgren (1961) published almost fifty years ago. He collected time-series data for corporate profits from 1920 to 1938, which he evaluated using Burns's and Mitchell's diffusion index. The indicator revealed a regular pattern of the cyclical diversities of corporate earnings: In the upswings of the economy the number of firms experiencing rising profits went up, but never exceeded 80 percent of the sample. During downswings the number decreased accordingly but never fell short of 20 percent.⁹ The numbers indicate that at every point in time there is a subset of firms which moves counter to the majority of the sample population. This subset of firms varies by size and economic weight: The longer an upswing prevails the more firms join the dominant movement of the economy. The same happens during the downswing. Firms are switching between the majority subset of declining firms and the minority subset of expanding firms. Thus, as the cycle moves on, the composition of the aggregate changes in a systematic way. The aggregate's turning point reflects the fact that the minority process has become the majority process.

Hultgren's paper, which was first presented at a business cycle conference in 1950, has never been cited and has fallen into oblivion, because mainstream economics at his time was predisposed toward Keynesian macroeconomics and had no theoretical use for cyclical variety changes.¹⁰ Hultgren's method, in a recent article (Schohl 1999a), has been applied to German data and similar patterns have been found for five postwar cycles. Hultgren's findings were also examined by using a set of different economic variables such as sales, gross production values, and profit rates, all of which behaved in a similar way: At each point in time two polar tendencies are coexistent. There is a majority process which controls the aggregate, and there is a minority process moving in the opposite direction. Firms shift between the two subsets in a cascade-like way. There is one cascade of firms moving from the majority subset to the minority subset. That is, firms pass their individual lower or upper turning points while the economy is still going down or up, respectively. The minority subset increases until it becomes the majority subset taking over control of the aggregate. Stated differently, the occurrence of macro-economic turning points is explained by a population process that starts long before the turning points actually happen.

Another piece of empirical evidence that can be utilized to advance Schumpeter's business cycle theory is a phenomenon called "countercyclical profitability spread," which has been observed by authors from various countries (Geroski and Machin 1993; Jeger 1994; Lianos and Droucopoulos 1993; Schmalensee 1989; and Schohl and Ipsen 1990). The term relates to the fact that firms are affected unevenly during the business cycle. This unevenness is most pronounced during downswings when the variance of the profit rates or of its changes goes up and reaches its peak at the recession troughs. It has been shown that the increase is

⁹See the chart in Hultgren (1961, p. 328).

¹⁰See, for example, the theoretically helpless comments of Hultgren's discussant Friend (1951) in the conference volume.

caused by a divergence among firms whose profits are declining in a recession and by another group of firms that have passed their individual recession troughs and have started moving up again while the economy is still going down (Schohl 1999b). As has been demonstrated by other authors, the countercyclical spread is caused by a divergence of innovating and non-innovating firms (Geroski and Machin 1993).

Putting together the empirical pieces to the puzzle, the following picture emerges. First, there has never been any evidence for the pooling of innovations at certain points in time nor for the similarity of the diffusion times. Product histories were found to be idiosyncratic entities that could not be usefully combined into groups of innovations having a similar economic thrust in the sense of Schumpeter's Kondratieff–Juglar–Kitchin scheme. Instead, firms are innovative all the time, selling products in all possible developmental stages of their respective lifecycles. Second, as a follow-up effect, the firms' economic biographies, which are nothing more than the combination of the firms' product histories in monetary terms, were found to be idiosyncratic as well. But this does not mean that the firm population of an economy is a structureless mass of dissimilar entities. To the contrary, the economic variety of the agents changes systematically over the cycle. These findings related to the countercyclical spread of the profitability dispersion and to the changing composition of the co- and counter-movements of the firms and the macro-cycle. These variety changes are the outcome of the competitive process and provide the point of departure for a disaggregative explanation of the business cycle in which the economic differences of heterogeneous agents play the crucial role.

**THEORETICAL ABSTRACTION:
A FORMAL MODEL OF THE BUSINESS CYCLE
APPLYING SPREAD MEASURES ONLY**

An Equation System Modeling the Mutual Dependence of Spread Variables

To set up a formal model of the business cycle that is capable of capturing both Schumpeter's explanatory approach as well as the empirical observations presented so far, several design decisions have to be made. The first decision concerns the variables of the model. One essential aspect of Schumpeter's explanatory approach is the demonstration that macrodynamics is the unintended outcome of the firms' competitive conduct. Therefore, the variables to be selected for the model should reflect the firms' market operations as well as their market revenues. As has been demonstrated in the previous section, there is empirical evidence on the profitability spread, which varies countercyclically. The spread was measured by using the variance of the annual profitability changes v_{PC} . This variance is suitable for the purpose at hand because it includes both the diversity of the firms' cyclical fates, and their changes over time. Therefore, v_{PC} is specified to be one of the model variables.

The next variable is supposed to capture the diversity of the firms' competitive market operations. As the innovation literature in the previous section shows, Schumpeter's approach of considering the rhythmical occurrence of pioneering innovations is not quite in accordance with the facts, because firms are innovative all the time by varying degrees of intensity. A generic variable that comprises the firms' market operations in their entirety may be called change of market offerings,

or offer changes (DOC). OC is supposed to include not only Schumpeter's core idea of primary innovation, but also all other forms of competitive actions such as secondary innovations and imitations of any kind. It also includes price changes which are an important parameter of action in the later stages of product life cycles, as well as all other forms of shaping offers that are different from before. This comprehensiveness of OC is a formal requirement, because it is supposed to be the explanatory variable for the annual profitability changes (PC), which is also a catch-all variable including economic gains and losses in their totality.

The last design decision concerns the specification of the equation system which can be used for modeling the mutual dependencies of the firms' market-conduct and market-performance variables. From the basic idea of Schumpeter's theory, it directly follows that equation systems needing an external propulsion for the generation of cycles are not suitable for the purpose at hand. Instead, the essence of Schumpeter's theory can only be met by equation systems which generate oscillations "from within themselves." This criterion requires application of the so-called "conservative systems," which produce non-dampened self-propelling oscillations over time merely from the interaction of the variables involved. The most simple conservative system of equations is the Lotka–Volterra system which is made up of two differential equations for two different variables.

The economic considerations for the specification of the equation system are as follows: If a single firm changes its market offerings, this has an effect on its profit rate, which may increase if the innovation is successful, and may decrease if it is not. For the whole population of firms, this means that there is always a variance of offer changes v_{OC} , because the nature of competition is to do things differently to attract potential customers. If the amount of novelty of market offerings differs among the competitors, e.g., if some agents perform pioneering innovations, the variance of the changes of market offerings goes up. If agents are doing similar things, i.e., if imitation prevails, v_{OC} goes down because the amount of product variety is lower than before.

Since innovations are usually economically successful or unsuccessful to varying degrees, there is always v_{PC} which is associated with the amount of changes of the variance of the offer changes. In formal notation, this consideration is represented by equation 1, in which v_{PC} is positively dependent on the growth rate of the variance of the offer changes (v'_{OC}):

$$v_{PC}(t) = a_1 + b_1 \cdot v'_{OC}(t) \quad \text{Equation 1}$$

The v_{PC} which has been generated by the above equation, however, affects v_{OC} in a different manner. Firms which have placed new offerings successfully on their respective markets, and have thereby improved their profitability position in relation to their competitors, have no need to proceed with modifications of their offers, because they now start earning money with a new and prosperous product portfolio. These products have left their experimental stage and have moved on to the expansionary phase of the product cycle. The characteristic of this stage is that the main features of the product have emerged. Further modifications are only useful insofar as they gradually continue improvement of its attributes. Therefore, the amounts of offer changes that have widened v_{OC} before, now necessarily have to decrease because the amount of novelty required for economic survival and

success is smaller than before. This makes up a negative feedback from v_{PC} to v_{OC} : High growth rates v'_{PC} reduce the variance of the offer changes. Equation 2 represents this economic consideration in formal notation:

$$v_{oc}(t) = a_2 - b_2 \cdot v'_{pc}(t) \quad \text{Equation 2}$$

Equations 1 and 2 constitute a system of Lotka–Volterra differential equations which captures the essence of Schumpeter’s business cycle theory. Its solution, which is the circular curve known from other applications of the Lotka–Volterra model, is presented in figure 1.¹¹ In order to avoid misunderstandings, it has to be stressed that the present application of the Lotka–Volterra equations is based on completely different economic considerations from previous applications of the model in business-cycle theory.¹² The first and most crucial difference is clear from looking at the variables. By comparison to traditional macroeconomic Lotka–Volterra models that employ sum-total aggregates, the present application employs variances. Thus, the focus is on the heterogeneity of the agents, and not on the value totals for the whole economy. The second crucial difference is that the underlying theoretical considerations are based on competitive market behavior, which is captured by a new type of generic variable: the changes of market offerings. These two differences have important consequences for the interpretation of the model. Figure 1 cannot be understood in the traditional macroeconomic way because it requires thinking in terms of varieties and variety changes. How the phase diagram has to be read economically will be worked out in detail in the following section.

Economic Interpretation of Cyclically Interacting Variety Variables

Before the economic interpretation of the model can start, two preparatory thoughts are necessary. The first one concerns the location of the cyclical stages in figure 1, which cannot be deduced by mathematical derivation because the equation system does not contain this information. It has to be taken from the empirical evidence mentioned above, which has revealed that v_{PC} reaches its peak at the recession troughs. From this fact it follows immediately that the lower turning point of the business cycle is located at point B. Furthermore, it follows that point D stands for the peaks, and finally, points A and C represent the middle of the downswings and upswings of the economy. Thus, the course of the business cycle is decomposed into four segments: early and late upswing plus early and late downswing.

The second preparation for the economic interpretation of the spread model concerns how to read the variables on the two axes of the phase diagram. Formally, both model variables are variances, which are evaluated across the changes of individual values of either offers or profitability. If a variance of this kind changes over time, it indicates that the differences of the individual changes have increased or decreased. The economic interpretation of this nested link of two different changes in one variable can best be explained by first considering v_{OC} , which makes up the y-axis in figure 1.

¹¹For a much more detailed presentation of the model and its mathematical solution, see Schohl (1999c).

¹²See, for example, the Goodwin model and the related literature (Goodwin 1967).

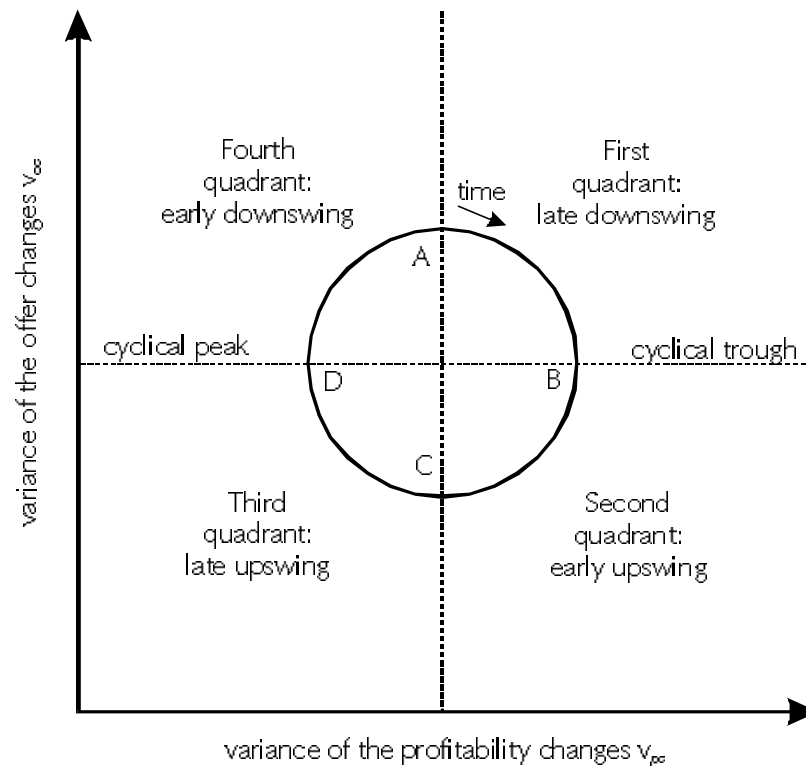


Figure 1
The Working of the Spread Model of the Business Cycle

In order to survive in competitive markets, firms have to be innovative all of the time. Therefore, offer changes are taking place all the time and, as has been explained in the previous section, the idiosyncrasy of the individual changes of supply widens a variance. The existence of a variance simply reflects the fact that Schumpeterian competition is going on. However, the intensity of competitive conduct not only differs across firms—thereby establishing the variance—but it also differs across time—thereby causing the variance to fluctuate. This is due to the fact that each firm can change the intensity of use of its competitive means if management deems it necessary. Thus, changes of the variance of the offer changes v_{oc} over time come about as the combined result of the variety of the individual changes of competitive conduct, which includes all conceivable forms of primary moves as well as all conceivable forms of competitive countermoves.

Two different effects on the variance have to be distinguished. First, if firms change their offers, this provides positive contributions to the variance. As already explained above, the numerical amount of the individual contributions to the variance reflects the degree of novelty that is realized. In any case, current offer changes contribute to an increase of the variance. Second, the effects of past offer changes have to be considered. Firms which have established a new or revised product or have realized any other form of modification of their offerings in the previous period, and do not make any further modifications in the current period,

do not contribute to the present value of the variance of offer changes because they supply the same product as before. Keeping supply constant results in a decline of contributions to the variance by comparison to the previous year. This, of course, also happens on the markets all the time: There is no need to change a new product which is sold successfully.

Thus, fluctuations of the variance of the offer changes v_{OC} cover the whole set of market actions: changes of supplies contribute spread-shares to the variance thereby raising its value. The decision to stop product changes implies a loss of spread-shares of the respective firms in comparison to the previous period, thereby lowering the value of the variance. The pulsation of the variance which is actually observed in historic time is the combined effect of these two contributing factors. It signals that by comparison to the previous year, one kind of contribution dominates the other one, while both are existent all the time, because the variety of the competitive situations of the individual firms in an economy requires that entrepreneurs apply all sorts of supply-related measures.

Similar mechanics applies to the variance on the x-axis of the phase diagram. The v_{PC} widens if large changes of one subgroup of firms produces positive contributions that overcompensate reductions of the alteration amount of the remaining population. It has to be stressed here that profit rates can also be negative. If a negative profit rate changes negatively, i.e., losses increase, this also enlarges the variance because of the square operation in the variance formula.

After these preparatory remarks, the emergence of the business cycle from the competitive interactions of heterogeneous firms can be explained by walking around the circle of the phase diagram. Let us first consider the upper half circle D-A-B, which stands for the recession. At point A, the variance of the offer changes is at its peak. The reason for this follows from the history before. Because A represents the middle of the downswing, there are many corporations which have already been hit by the early recession. We know from the analysis of the Hultgren indexes mentioned in section 2 that the firm population is not pulled into the downswing simultaneously, but that the number of firms which are hit by the recession increases incrementally. Therefore, while traversing from D to A, the number of firms that are compelled to change their offerings increases in a stepwise mode as well. The contributions of these firms to the variance of the offer changes increase both by number and by amount, thus making up its rise in the early downswing of the macroeconomy.

After passing point A, the variance of the supply changes does not increase further but starts sinking. This is due to the fact that the "early-recession-firms" which have joined into the downswing around D have been working on an improvement of their products since then. These firms have, one after another, finished their innovations and have started selling their improved product offers. If sales increase, it is not useful for this group of firms to make further modifications to their product program, because its renewal has been successful. The contributions of this group of firms to the variance of the offer changes v_{OC} starts to decrease stepwise already between D and A, as the number of firms which have finished their offer changes increases in the course of the recession. Although the overall variance of the supply changes is still increasing between D and A, because of the rising number of firms entering the recession, the countermovement is slowly swelling.

After passing point A, the countermovement starts to dominate. While the downswing is still moving on and is approaching the cyclical trough at B, there are still corporations entering into the recession, as the Hultgren index has shown in section 2. These "late-recession firms," which are forced to change their offerings are making contributions to the variance of the offer, but as the recession has already endured a fairly long run, most of the firms not only have already been affected by a decline of their sales, but they have even finished the renewal of their product program. Thus, the exits from the variance of the supply changes dominate the entries. This explains the decline of v_{OC} between A and B.

The driving force of the changes of competitive conduct is made up of the changes of profitability, the variety of which is displayed by the second dispersion variable v_{PC} . From the empirical observations presented in the previous section, we know that v_{PC} increases during the downswing. This is due to two opposite tendencies within the firm population. While firms entering the recession have to accept a decline of their profits or even have to suffer from losses, the value distribution widens downwards. At the very same time, however, firms that have innovated successfully can increase their profits, thereby spreading the value distribution upwards. The combined effect of these two opposite drifts makes up the rise of v_{PC} during the the downswing. Or stated in reverse, changes of v_{PC} indicate changes of the frequency distribution of the two divergent effects within the firm population. This inference guides the following analysis of the right half of the figure.

The A-B-C segment of the circle is particularly interesting because it includes the lower turning point. From the previous examination, we know that in the late downswing, i.e., while moving from A to B, v_{OC} goes down because the firms one after another finish modernization of their product program, which results in a reduction of their contributions to v_{OC} . At the same time, v_{PC} widens because these firms, the primary movers on their respective markets, realize extra profits by setting themselves apart from their competitors. However, the counterdrift is also working, coincidentally, because the late-recession entrants suffer from losses which also widen the v_{PC} .

It is important to keep in mind very clearly that both kinds of drift are not made up of homogeneous blocks of identical agents. Instead, the heterogeneity of the firms and the idiosyncrasies of their market positions and market actions result in some sort of staggering. Firms are hit by the recession at different times with different force, and struggle out of their individual crises at different times by applying different measures. This observation sheds a new light on the lower turning point of the business cycle: At point B, two different cascades are interchanging. The first cascade is made up of primary movers which have been hit by the recession early, i.e., somewhere between D and A, one after another, and manage to get out of it somewhere between A and B. This cascade of firms gradually raises its individual sales and increases its production activity correspondingly in a stepwise mode. Thus, the cloud of firms starting up their factories begins to swell in the late downswing.

However, between A and B this upward drift does not yet affect the direction of change of aggregate production of the macroeconomy, which is still continuing its recessionary path. The prevailing macro-state is determined by the second cascade of firms that are suffering from production reductions at this point in time as has been revealed by analyses of the Hultgren indexes mentioned in section 2.

While this cascade of firms makes up the downward course of the aggregate business cycle because it dominates numerically, its downward drift loses power incrementally because firms which are affected by the recession start improving their offers. If the reversals of competitive conducts of the respective firms prove to be successful on the respective markets some time afterwards, it implies a shift of the respective corporations from the descending to the ascending cascade of firms: the recession gradually fades away. Its end is signaled by traditional aggregative macro-indicators if they change direction. In figure 1, this happens at point B. Thus, the characteristic of the lower turning point of the macroeconomic business cycle is simply that at this point in time the cascade of firms expanding their production overrules the cascade of the depressing firms both by number and by numeric weight.

After passing B, i.e., after the upswing begins, the features of the firm population continue to transform themselves endogenously. While the first movers have already stepped ahead of their competitors between A and B and have widened v_{PC} , they are now followed by the cascade of the second movers. This can be concluded from the y-axis of figure 1, which displays a decline of the innovativeness of the new offers. The character of competition also changes because imitations now gain increasing weight on the markets. This not only reduces the individual firms' respective contributions to v_{OC} , as is displayed on the y-axis, but at the same time results in increasing pressure on price, which subsequently reduces the profitability advantages of the early movers. This makes v_{PC} go down, as the model displays on the x-axis.

It is important to stress once again that changes of the variance always have to be interpreted as changes of the *heterogeneity* of the phenomenon under consideration. Thus, it is not allowable to conclude from the decrease of v_{PC} that innovations no longer occur and that firms start waiting until imitating firms have competed their profits away. As the mere existence of the unceasing business cycle already indicates, market dynamics do not come to a halt. Even while traversing from B to C, primary innovations do occur as they do anywhere in the course of the cycle. The present decline of the variance of the profitability changes v_{PC} only reflects the fact that the cascade of the first movers' profitability advantages, which has widened the variance between A and B, is now narrowed by the cascade of the imitating competitors, which gains increasing weight in the expansionary phase of markets.

While competitive pressure on extra profits continues to rise in the course of the upswing and narrows the variance of the profitability changes, this very same pressure stimulates offer changes in order to escape the decay of profits. The need to do so is of increasing importance for the cascade of the first movers, which has widened the profit variance in the late downswing, i.e., between A and B, and has thereby reversed the course of the macro-cycle. This cascade of firms has been working on changes of its offerings in the meantime, and has placed them on their respective markets at those points in time after B, which appeared to be useful for the respective managements.

As the upswing proceeds, output of finished, capacity-enlarging factory investments increases supplies on the markets causing the share of firms being affected by a decay of their profits to rise, which in turn implies an increasing need to improve offerings. It follows that there has to be a point in time when the cascade

of imitating product changes is overcompensated by the cascade of newly launched product placements by which early movers try to set themselves apart from their competitors. This is precisely what happens after passing C. While competitive pressure continues to rise due to the cascade of finished, expansionary, investment projects, and thereby narrows the spread of profit rates v_{PC} , the variance of the offer changes v_{OC} slowly starts widening again.

However, the variance of the profitability changes continues to decline between C and D. This is only because increasing rivalry on markets approaching saturation is still the dominant characteristic of this stage of the business cycle. It is the majority phenomenon which generates the course of the traditional macroeconomic aggregative indicators and—the new observation here—also affects the variance. But from this observation, one cannot conclude that all the firms are suffering from a decline of their profitability. This inference is inhibited quite naturally by the fact that we are analyzing the variance and not the mean of the frequency distribution. Therefore, the heterogeneity issue can never move out of the field of view.

Some of those firms that have started offering modified supplies may realize extra revenues immediately, while others may follow at later points in time, because the characteristics of their respective innovation may require some time of diffusion or maturation. Once again, all conceivable forms of idiosyncrasies are present and have to be taken into consideration if the goal of economic analysis is to explain a real-world phenomenon. With the points in time at which the revenues from product innovations start coming in also being a spread phenomenon, the variance of the profitability changes starts increasing when this cascade of market operations has gained enough force to be detected by the variance method of measurement. This happens right after passing point D, at which opposing cascades are changing dominance. Thus, the profitability spread is moving up again, and the variety of the firm population once again has changed its composition endogenously.

SUMMARY AND CONCLUSION

By comparison to Schumpeter's market-process based theory of the business cycle, several features of the spread model have to be highlighted. First, one of the weakest points of Schumpeter's approach was the idea that innovations occur in clusters. In the present article, the conception of the innovation "swarm" has been translated to the "variance." This relaxes Schumpeter's simultaneity assumption. It is not necessary to defer competitive actions until the economy has attained a point of rest. Entrepreneurs who execute changes of their market offers at any time in the real world are allowed to do so in the model as well. They do not have to wait until competitors have caught up. They may also wait or be too slow and fall behind. Or they may even stop competing and change their field of operation. So at any point in time there is a dispersion of different competitive actions, which is reflected in the spread model by using the "variance" notion.

Second, as a followup feature of this modification, the grouping of innovations into different categories of economic thrust is rendered superfluous. The old three-wave scheme is removed completely from the theory. There is no need to decompose the irregular course of a historical time-series into regular components. Instead, the spread-model is based on the idea that macroeconomic time-series are the aggregate outcomes of a multitude of idiosyncratic processes. The only regularity on which the model is based is the empirical fact that there are

cyclical changes of the agents' economic varieties. From this, it directly follows that the spread model does not rely on the equality of the products' diffusion times and the wave-length of the business cycle. There is no need to link microeconomic and macroeconomic duration variables. Thus, another counterfactual restriction of Schumpeter's approach is eliminated.

Another point of critique that has been raised against Schumpeter's theoretical setup is his reference to the equilibrium notion, which loses its economic meaning if it is applied to superimposing waves. The spread model is not affected by this logical difficulty because it does not require the assumption of a fictitious stable state for the whole economy. Such an assumption may be a helpful device for an unrelated outside observer who needs a point of reference for his analysis. From an entrepreneur's point of view, the situation is different because for him it is more important to know how his relative position is affected by his competitive moves or by competitive attacks of his rivals. The spread model captures the different information requirement by locating each firm's position within the variance of observations and by deriving its dynamics from the positional changes as they are produced by the market process. Thus, the Schumpeterian equilibrium notion has been translated into the firms' relative positions in the value distribution, which provide idiosyncratic points of reference for idiosyncratic competitive moves of idiosyncratic agents.

In this regard, the spread model stands in theoretical contrast to real-business-cycle models that crucially rely on the equilibrium notion. It is the virtue of those models to have demonstrated how the trade cycle phenomenon can be incorporated into equilibrium theory. But this was achieved at the price of heroic and counterfactual assumptions, such as continuous optimization of rationally expecting representative agents. In a world like this, the economic existence of a firm is never endangered by competitive attacks of its rivals because it is removed from RBC theory by applying the representative-firm assumption. By logical necessity, the dynamics of RBC models then have to be imposed from the outside through macroeconomic productivity shocks, the source of which has to remain unexplained. The spread-model avoids all this by permitting the agents to be creative individuals who have to survive in a competitive environment by continually reshaping their market offerings.

Another implication of the spread-model relates to the Keynesian downward spiral, which starts spinning if wage payments are cut back. If consumption expenditures decline, investment goes down accordingly. This further accelerates decline of demand which, in turn, induces additional cutbacks of wages. This spiral chain of effects is afflicted with a typical problem of aggregative reasoning: If all of the subjects of an economy are tied to one single macro-agent, there is no endogenous way to stop the spiral. Within this typical Keynesian macro-logic, only the state can help by injecting artificial demand. The spread-model provides no point of attachment for spiral reasoning because there is no representativity assumption that forces the model agents to behave in a similar way. To the contrary: Individual turning points that were observed in reality to happen at any time during the downswing are permitted in the model in a similar way. Thus, the lower turning point of the aggregate is just that point in time at which the upward forces have gained enough strength to overcompensate the downward forces. Within the spread logic, the turning point is an endogenous phenomenon which is

generated from within the market system by competitively acting heterogeneous firms. It is not necessary to resort to exogenous factors such as Keynesian state intervention or unexplained RBC technology shocks. The cycle-maker is the market process which generates macroeconomic fluctuations from within the system. In this respect, the spread-model utilizes the explanatory principle of Schumpeter's market-process based theory of the business cycle without adopting its flaws. Future research should be directed to more profound studies of the variety of the agents' competitive moves and countermoves in order to fill the model variable "variance of offer changes v_{OC} " with empirical content. Schumpeter's (1951, p. 155) claim to examine "how firms rise and decline . . . and how this rise and decline affects the aggregates" is still a neglected issue on the profession's research agenda.

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