Industry Evolution: Diversity, Selection and the Role of Learning

David B. Audretsch*, Patrick Houweling** and A. Roy Thurik***

*Tinbergen Institute of the Erasmus University Rotterdam and Georgia State University

**Centre for Advanced Small Business Economics (CASBEC), Erasmus University Rotterdam

***Tinbergen Institute and Centre for Advanced Small Business Economics (CASBEC), Erasmus University Rotterdam and EIM Small Business Research and Consultancy

Januari 1998

Keywords: Evolution, Learning, Diversity, Selection, Survival, Exit

The authors would like to give special thanks to John Groenewegen and Luuk Klomp for their comments and suggestions and to Statistics Netherlands for providing data.

In terms of the theory of the firm and industry, neoclassical economics has been confronted by two failures. The first is to explain why firms differ from each other, that is why firms are heterogeneous [Commons, 1934; Hodgson, 1993a]. Neoclassical economics assumes a representative firm in each industry, which contradicts a wealth of case study evidence and empirical observation that, in fact, firms are not at all identical clones of each other. As Nix and Gabel [1996, p. 737] point out, "Differences in the behavior of firms facing similar environments is strong evidence that institutional details are needed."

The second failure of neoclassical economics is to explain why people start new firms which are seemingly suboptimal in the sense that they are too small to be viable in the longer run. Neoclassical economics strains to reconcile seemingly irrational behavior with a model that explicitly assumes that all economic agents are rational [Hodgson, 1993b and Groenenwegen et al., 1995].

On the other hand, institutional and evolutionary economics provide an understanding of the role of knowledge that enables both the diversity of firms and the propensity for people to start new firms also to be understood [Costello, 1996]. The fundamental tenets of evolutionary economics involve the creation of diversity and the selection mechanism [Schumpeter, 1911 and 1942 and Nelson and Winter, 1982]. Knowledge in neoclassical economics is assumed to be certain, symmetric and involves no costs in its transactions [Dosi, 1988]. By contrast, institutional economics recognizes exactly the opposite – that new economic knowledge is inherently uncertain, asymmetric and involves substantial costs to transact [Hodgson, 1993a and 1993b]. This results in a divergence in beliefs about the value of new ideas. Neoclassical economics is unable to explain entrepreneurship. But institutional economics, in its emphasis on the *qualitative nature* of knowledge, provides the framework for

understanding that entrepreneurship creates a diversity of new firms that are a response to people valuing new ideas differently.

The purpose of this paper is to show how institutional and evolutionary economics provide better insights as to why some firms survive and others do not than does neoclassical economics. At the heart of the evolutionary theory is the view that new firms are a manifestation of diversity and that their subsequent survival is shaped by the selection process. In his 1997 Presidential Address to the Association for Evolutionary Economics, John Groenewegen [1997] emphasized the distinctions between types of capitalism in North America, Japan and Europe. Despite immense institutional and historical differences across these different economic systems, evolutionary economics explains the role that diversity, selection and learning play in economic development.

Diversity and Entrepreneurship

Professor Coase [1937] of the University of Chicago was awarded a Nobel Prize for explaining why a firm should exist [Medema, 1996]. But why should more than one firm exist in an industry? Coase [1937, p. 23] himself asked, “A pertinent question to ask would appear to be (quite apart from the monopoly considerations raised by Professor Knight), why, if by organizing one can eliminate certain costs and in fact reduce the cost of production, are there any market transactions at all? Why is not all production carried on by one big firm?” One answer to Coase’s question is provided by neoclassical economics. An excess level of profitability induces entry into the industry. And this is why the entry of new firms is interesting and important to neoclassical economics – because the new firms provide an equilibrating

function in the market, in that the levels of price and profit are restored to the competitive levels.

Under neoclassical theory, outputs and inputs in an industry are assumed to be homogeneous. That is, the entry of new firms is about business as usual – it is just that with the new entrant there is more of it. In the neoclassical model, the entry of new firms is about restoring the market back to equilibrium by adjusting output in the market, but not about innovation or entrepreneurship.

In fact, in the neoclassical world of perfect knowledge with no uncertainty, asymmetries and no costs of transacting knowledge, all entrepreneurship would take place within the existing incumbent organizations. If an individual, say an engineer, scientist or other worker, has an idea for doing something different than is currently being practiced by the incumbent enterprises --- both in terms of a new product or process as well as in terms of an organizational change --- the idea would be presented to the incumbent enterprise. Perfect knowledge would ensure that both the firm and the agent would agree upon the expected value of the idea, so that the agent with the new idea would have no incentive for taking the idea outside of the organization. Diversity would manifest itself within the existing firms and organizations.

But as the late Hyman P. Minsky [1996, p. 364] emphasized in his acceptance remarks upon receiving the Veblen-Commons Award from the Association for Evolutionary Economics, we are living in an “age of heightened uncertainty.” By uncertainty, Minsky [1996, p. 360] means, “Uncertainty (or unsureness) about what the outcomes will be follows from the uncertainty with which agents hold the model that guides their actions. Agents are not only

unsure about the validity of the model that guides their actions, they impute such uncertainty to the other actors in the economy."

Minsky [1996, p. 360] points out that the power of neoclassical economics "was derived from the heroic specification of the model that agents use to guide decisions…The heroic specification was that all agents have a common understanding of the environment within which they operate." New economic knowledge is anything but certain. Not only is new economic knowledge inherently risky, but substantial asymmetries exist across agents. This means that the expected value of a new idea is likely to be anything but unanimous between the inventor of that idea and the decision maker, or group of decision makers in the firm. As Frank Knight [1921, p 268], observed, "With the introduction of uncertainty – the fact of ignorance and the necessity of acting upon opinion rather than knowledge – into this Eden-like situation (that is a world of perfect information), its character is entirely changed…With uncertainty present doing things, the actual execution of activity, becomes in a real sense a secondary part of life; the primary problem or function is deciding what to do and how to do it."

Institutional economics recognizes that economic knowledge is not certain and symmetric with no costs of transactions, but instead is uncertain, highly asymmetric and associated with substantial transactions costs, resulting in divergences in beliefs about the expected value of new ideas. Such differences in beliefs about the expected value of new ideas, lead people, at least in some cases, to start a new firm. In such situations, diversity is manifested through entrepreneurship in the form of a new-firm startup. As Williamson [1975, p. 201] points out, "Were it that large firms could compensate internal entrepreneurial activity in ways approximating that of the market, the large firm need experience no disadvantage in entrepreneurial respects. Violating the congruency between hierarchical position and compensation appears to generate bureaucratic strains, however, and is greatly complicated by

the problem of accurately imputing causality." This leads Williamson [1975, pp. 205-206] to conclude that, "I am inclined to regard the early stage innovative disabilities of large size as serious and propose the following hypothesis: an efficient procedure by which to introduce new products is for the initial development and market testing to be performed by independent inventors and small firms (perhaps new entrants) in an industry, the successful developments then to be acquired, possibly through licensing or merger, for subsequent marketing by a large multidivision enterprise."

In its characterization of knowledge as being uncertain, symmetric and associated with no or trivial costs of transaction, the neoclassical model errs in its characterization of entrepreneurship. Economic agents do not start firms to clone existing organizations and simply add output to the market. Rather, they start firms because they have access to different ideas and value those ideas differently. In order to pursue what is held as a valuable idea, an agent starts a new firm.

For example, Chester Carlsson started Xerox after his proposal to produce a (new) copy machine was rejected by Kodak. Kodak based its decision on the premise that the new copy machine would not earn very much money, and, in any case, Kodak was in a different line of business – photography. It is perhaps no small irony that decades later this same entrepreneurial startup, Xerox, turned down a proposal from Steven Jobs to produce and market a personal computer, because they did not think that a personal computer would sell, and, in any case, they were in a different line of business – copy machines. After seventeen other companies turned down Jobs for virtually identical reasons, including IBM and Hewlett Packard, Jobs resorted to starting his own company, Apple Computer.

Similarly, IBM turned down an offer from Bill Gates, "the chance to buy ten percent of Microsoft for a song in 1986, a missed opportunity that would cost $3 billion today." IBM reached its decision on the grounds that "neither Gates nor any of his band of thirty some accomplices had anything approaching the credentials or personal characteristics required to work at IBM."[1]

Divergences in beliefs with respect to the value of a new idea need not be restricted to what is formally known as a product or even a process innovation. Rather, the fact that economic agents choose to start a new firm due to divergences in the expected value of an idea applies to the sphere of managerial style and organization as well. One of the most vivid examples involves Bob Noyce, who founded Intel. Noyce had been employed by Fairchild Semiconductor, which is credited with being the pioneering semiconductor firm. In 1957, Noyce and seven other engineers quit en masse from Schockley Semiconductor to form Fairchild Semiconductor, an enterprise that in turn is considered the start of what is today known as Silicon Valley. Although Fairchild Semiconductor had "possibly the most potent management and technical team ever assembled" [Gilder, 1989, p. 89]. "Noyce couldn't get Fairchild's eastern owners to accept the idea that stock options should be part of compensation for all employees, not just for management. He wanted to tie everyone, from janitors to bosses, into the overall success of the company…This management style still sets the standard for every computer, software, and semiconductor company in the Valley today…Every CEO still wants to think that the place is being run the way Bob Noyce would have run it" [Cringley, 1993, p. 39]. That is, Noyce's vision of a firm excluded the dress codes, reserved parking places, closed offices, and executive dining rooms, along with other trappings of status that were standard in virtually every hierarchical and bureaucratic US corporation. But when he tried to impress this vision upon the owners of Fairchild Semiconductor, he was flatly rejected.

The formation of Intel in 1968 was the ultimate result of the divergence in beliefs about how to organize and manage the firm.

By oversimplifying the fundamental characteristics of new economic knowledge, neoclassical economics has focused on the firm in the process of entry and overlooked the fact that it is individuals who actually start firms. Reshifting the lens to the individual in possession of knowledge which is uncertain, asymmetric and inherently costly to transact, leads to a strikingly different economic role for the new entrant – not to equilibrate the market by increasing the supply of a product already being produced by the incumbent firms – but rather by doing something different and thereby serving as an *agent of change*. This role is reminiscent of the concepts of *voice* and *exit* introduced and popularized by Albert O. Hirschman [1970]. An agent in possession of potential new economic knowledge may be unable to exercise *voice* in the context of the decision making hierarchy of an incumbent firm, that is, to actualize her potential innovation within the boundaries of an incumbent enterprise. This drives her to choose instead to exercise *exit* -- out of the incumbent enterprise, and ultimately to start a new firm.

Where does diversity come from and how is it manifested? One manifestation is the emergence of a new firm, which is based on a different evaluation of some set of ideas. We should emphasize that entrepreneurship in the form of a new-firm startup is certainly not the only manifestation of diversity. But it is a manifestation of diversity that remains invisible through the lens provided by neoclassical economics.

Selection and the Two Types of Learning

A more institutional approach to thinking about new economic knowledge leads to the conclusion that people will start new firms in an attempt to appropriate the expected value of their new ideas. Divergences in the expected value regarding new knowledge suggest that some agents will value a given idea more than other agents, including those involved in the decision making process of incumbent firms. When such divergences occur, an agent may choose to exercise what Hirschman [1970] has termed as *exit* rather than *voice* by departing from an incumbent firm to launch a new enterprise. But the question remains, who is right, the departing agent or the organizational hierarchy which by assigning the new idea a relatively low value, has effectively driven the agent with the potential innovation away? *Ex post* the answer may not be too difficult. But given the uncertainty inherent in new knowledge, the answer is anything but easy *a priori*.

Thus, when a new firm is launched, its prospects are shrouded in uncertainty. This uncertainty becomes reduced through the selection process of the market. The role of learning in the selection process has been the subject of considerable debate. On the one hand is what has been referred to as the Lamarckian learning, which refers to adaptations made by the new enterprise. In this sense, those new firms that are the most flexible and adaptable will be the most successful in adjusting to whatever the demands of the market are. As Nelson and Winter [1982, p. 11] point out, “Many kinds of organizations commit resources to learning; organizations seek to copy the forms of their most successful competitors.”

On the other hand is the interpretation of learning in the Darwinian sense [Winter, 1964]. Under this interpretation the new enterprise is not necessarily able to adapt or adjust, but receives information based on its market performance with respect to its fitness in terms of meeting demand most efficiently vis-à-vis rivals. The theory of organizational ecology

proposed by Michael T. Hannan and John Freeman [1989] most pointedly adheres to the notion that, “We assume that individual organizations are characterized by relative inertia in structure.” That is, firms learn not in the sense that they adjust their actions as reflected by their core competence but in the sense of their perception. What is then learned is whether the firm has *the right stuff* but not how to change that stuff.

One of the more startling facts about new firms is their small size– their mean size in manufacturing is around seven employees [Audretsch, 1995]. The static lens provided by neoclassical economics concludes that such small firms are suboptimal since they are not able to fully exploit scale economies. Weiss [1991, p. 403], for example observes that, “The term ‘suboptimal capacity’ describes a condition in which some plants are too small to be efficient.”

However, seen through the evolutionary lens of institutional economics, a new firm begins at a small – even suboptimal scale output – and then, if merited by subsequent performance, expands. Those firms that are successful survive and grow, whereas those that are not successful will remain small and may ultimately be forced to exit from the industry.

The diversity in evaluating new ideas drives people to start new firms. The selection mechanism leads some of those new firms to survive while others exit. Thus, what appears to be inefficient through the static lens of the neoclassical model is an efficient method of learning when viewed through the dynamic lens of evolutionary economics.

Who Survives and Who Doesn’t

The ability to analyze which new firms survive and which do not depends upon access to a longitudinal data set containing observations tracking firms over time. Such data bases have now been used to study the likelihood of survival of manufacturing firms in the United

States, Germany, Canada, Portugal and Italy. However, these data sets suffer from severe drawbacks. For instance, the USELM file from the U.S. Small Business Administration provides only biennial observations on variables such as employment level and ownership status. It has been used for a series of studies on new-firm survival on the level of individual enterprises and establishments by Audretsch [1991 and 1995] and Audretsch and Mahmood [1995].

For our goal we need time series of considerable length. We use the longitudinal data base of manufacturing firms in the Netherlands from the Annual Production Statistics compiled at Statistics Netherlands. The Production Statistics contain detailed information on all firms in Dutch manufacturing. Data are available for each year between 1978 and 1992. In 1987 a structural change occurred in the sampling procedure: the Production Statistics until 1986 contain all establishments with at least ten employees, whereas data sets from the years after 1986 consist of all firms with at least twenty employees and only a sample of the firms with less than twenty employees. The percentage of firms dropping out of the data base because of this shift is only two.

A new firm is identified when it appears in the data file in year *t* but not in any of the years preceding *t*. The firm is considered to exit if it is present in the year *t* but not in year *t+1*, *t+2*,...1992. This longitudinal check is necessary, because in addition to a permanent closing down of its operations, a firm may not be in a particular year's data base, because its employment level has temporarily dropped below the limit of ten employees. Following Wagner's [1994] recommendation that, .."conclusions should not be based on the analysis of data from a single cohort of entries", we extract four distinct cohorts of new firms from the data base to analyze the post-entry performance. These four cohorts consist of new-firm

startups in each year between 1979 and 1982. Each enterprise is then tracked over the subsequent ten years.

The traditional industrial organization literature in neoclassical economics suggests that structural barriers impede new firms from entering new industries. These structural barriers typically take the form of industry-specific characteristics such as the importance of scale economies, the degree of capital-intensity and R&D intensity, since new firms lack the resources to acquire capital and R&D. Neoclassical theory has not stood up to the empirical evidence. As Audretsch [1995] shows, people start firms even in industries characterized by high entry barriers.

Evolutionary theory provides an explanation for the phenomenon that neoclassical theory is incapable of predicting -- the propensity for people to start new firms even in capital-intensive and R&D intensive industries. The only way agents can discover the actual value of their ideas is through experimentation in the market. To do this they start a new firm. If they discover that their idea is viable in the market the new firm expands and grows. But what about those entrepreneurs who discover that they do not possess *the right stuff* and are unable to expand and grow? The consequences of not being able to grow will depend, to a large degree, on the extent of scale economies. Thus, in markets with only negligible capital intensity and scale economies, firms should have a considerably greater likelihood of survival. However, where capital intensity and scale economies play an important role the likelihood of survival should be considerably less. The larger the extent of scale economies in the industry, the greater is the resulting cost disadvantage for small entrants and the lower is the probability of their survival. Measures of economies of scale are average firm size and average capital intensity of the industry. Therefore, we expect that an increase in either *startup size*, measured as the number of employees, or *capital intensity* of the entrant results in a higher likelihood of

survival given the scale of the industry, i.e., given the average firm size and the industry capital intensity. Since firms tend to be larger in some industries than in others, we include the mean industry firm size to control for the average size of firms in an industry. This is also true for capital intensity.

The greater the degree of uncertainty about new ideas in an industry, the lower will be the likelihood that any particular new firm will actually be based on a viable idea and ultimately survive. While it is not possible to measure the degree of uncertainty in an industry, Audretsch, Menkveld and Thurik [1996] show that industries where R&D plays an important role tend to be characterized by high uncertainty, asymmetric knowledge and high costs of transacting that knowledge. This is measured as the share of total industry employment accounted for by employees involved in R&D. We expect *R&D* to be negatively related to the likelihood of new-firm survival. Similarly, industries in the early stages of the life-cycle, as measured by growth, also tend to be characterized by high uncertainty. The *industry growth rate* is measured as the average of the annual industry sales growth rates between 1978 and 1991.

The firm's *debt structure* is hypothesized to have a positive influence on its chances of survival. Caves and Porter [1976] argue that in the phase following the firm's entry, a high level of financial investment serves as a high barrier to exit. We also include the debt structure of the industry to control for the mean debt structure of other firms in the industry.

Learning is promoted by a higher price-cost margin, since this reduces the inherent cost disadvantage confronting new entrants. We measure the *price-cost margin*, which indicates industry profitability, as (Revenues-Costs)/Revenues, where Revenues equals value-of-shipments plus the margin on trading and other revenues, and Costs equals the sum of total consumption value, labor costs, interest expenses (less interest income), miscellaneous income

(less expense) and depreciation costs on fixed assets. Weiss [1976] argues that the existence of small (suboptimal) firms is promoted in industries where price is set above the MES level of average costs. Hence, we expect that survival rates are higher in industries with higher *price-cost margins*. The literature on organization ecology [Hannan and Freeman, 1989] suggests that the likelihood of any new firm surviving will be lower when it is forced to compete with a large number of other new-firm entrants. Thus, we include the *entry rate*, measured as the number of new firms divided by the total number of firms in the industry, computed in the startup year. Finally, we also include three dummy variables representing the influence of the specific cohort to which the firm belongs. These dummy variables can be interpreted as reflecting the impact of omitted macroeconomic variables specific to the startup year.

The industry-specific variables *average firm size, industry capital intensity* and *industry debt structure* are included to accurately measure the corresponding firm effect. Next to this use as control variables, they are expected to have a direct impact on survival rates. The expected signs of *average size* and *industry capital intensity* are negative, because both variables can be seen as measures of economies of scale and a larger minimum efficient scale (MES) results in higher cost disadvantages for small firms. The *industry debt structure* can again be seen as a barrier to exit and is therefore expected to reduce the propensity to exit.

To identify who survives and who does not, we use a logit regression model where the dependent variable is assigned a value of one if the firm still exists and zero if it has exited. This model is estimated for different post-entry time intervals, varying between two and ten years. After estimating the model for each cohort separately, we were not able to reject the hypothesis that the regression coefficients of the variables differ significantly across cohorts. We conclude that it is appropriate to pool the four cohorts together in estimating the model. Because for several variables the mean value was different for different cohorts, it was

necessary in the pooled regression to work with standardized variables, i.e. from each variable we subtracted its cohort average.

The results for the even years are provided in Table 1. The coefficient of the firm-specific variable *startup size* is statistically significant for all estimated time periods. Its positive sign indicates that surviving is easier for firms that are larger at entry, given the industry's average firm size. The magnitude of this effect is decreasing over time. The *average size* in the industry does not seem to have a significant effect on the likelihood of survival. This holds for all considered time intervals.

Capital intensity has a positive influence on survival rates on the firm-level and a negative influence on the industry-level. As capital intensity is usually seen as a measure of economies of scale, these findings suggest that new-firm survival rates are lower in industries with substantial economies of scale and hence greater cost disadvantages for small firms. For a given scale of the industry, the firm can increase its chances of survival by increasing its own scale, but the effectiveness of this strategy is decreasing over time.

The impact of *debt structure* on the likelihood of survival becomes statistically significant in the sixth year subsequent to entry. Its negative sign contradicts the hypothesized positive effect. The positive sign of the industry *price-cost margin* supports Weiss' [1976] finding that survival is easier in industries where prices are set above the MES level of average costs. Interestingly, a high price-cost margin only provides an umbrella facilitating learning in the short run, as can be seen from the magnitude of its coefficient.

The impacts of the industry-specific factors *R & D* and *growth rate* on the likelihood of survival are both negative. This supports the hypothesis that survival is more difficult for firms entering an industry in the earlier stages of the life-cycle where the knowledge conditions tend

to be characterized by high uncertainty, asymmetries and high transactions costs. The impact of the *entry rate* is statistically significant for all considered time spans, supporting the theory in the organizational ecology literature that the likelihood of survival is reduced by the number of other new firms.

Taken together these results indicate that the likelihood of firm survival is shaped by the knowledge conditions of the industry. In industries with greater uncertainty, as reflected by a higher R&D intensity and growth rate, the likelihood of new-firm survival is lower. Entrepreneurs start new firms in industries where new knowledge plays an important role and learn about the viability of the new ideas through subsequent market experience. If the entrepreneur learns that the idea upon which the new enterprise is based is viable, the firm expands and grows. But what happens to those firms which are not viable? The answer is "It depends." In industries which are capital-intensive and scale economies play an important role, new firms unable to grow will be forced out of the market, as indicated by the negative relationship between industry capital intensity and new-firm survival as well as startup size and new-firm survival.

Conclusion

Neoclassical economics failed to explain why people start new firms, even in industries where so-called *barriers to entry* exist, such as scale economies and R&D. This failure is the result of incorrect assumptions about the nature of knowledge in the economy. The neoclassical model assumes that new economic knowledge is certain, symmetric and associated with no costs of transaction. By contrast, evolutionary and institutional economics take a different view knowledge. According to this view, new economic knowledge is better

characterized by uncertainty, asymmetries and is associated with substantial costs of transaction.

As long as new information is consistent with the routines established in an incumbent organization, it will be processed by economic agents and a decision making hierarchy. A more fundamental problem arises, however, when the nature of that new information is such that it can no longer be processed by the familiar routines. Under these circumstances the organizational routines for searching out new relevant information and making (correct) decisions on the basis of that information break down. And it is under such information conditions that divergences tend to arise not only among economic agents in evaluating that information but also between agents and organizational hierarchies. We find that in industries where the knowledge conditions are the most uncertain, asymmetric and associated with high transactions costs -- R&D intensive and high growth industries -- new firms have the lowest likelihood of survival. Neoclassical economics was wrong in predicting that entrepreneurs would be deterred from starting new firms in highly innovative industries where R&D plays an important role. What was assumed to be a barrier to entry in neoclassical economics is actually a barrier to survival in evolutionary economics.

We also find that the new firm is in some sense living on borrowed time. To the extent that the new firm is confronted by scale economies in the industry, it must grow in order to become viable. Thus, capital-intensity, like R&D intensity is a key element of the selection mechanism.

If each economic agent were identical, such divergences in beliefs would not arise. The greater the degree of heterogeneity among agents, the greater the tendency will be for beliefs in evaluating uncertain information to converge. But individuals are not homogeneous. Rather,

agents have varied personal characteristics and different experiences that shape the lens through which each agent evaluates where to get new information and how to assess it[2]. That is, reasonable people confronted by the same information may evaluate it very differently, not just because they have different abilities, but because each has had a different set of life experiences which shapes the decision making process. Perhaps this helps to explain why IBM, for all its collective knowledge, not to mention resources, was proven wrong about its early rejection of the microcomputer. Steve Jobs, a college dropout, was able to see something that the decision making hierarchy at IBM did not. After all, Jobs emerged from the milieu of computer hackers and freaks in Northern California that provided him with experience and knowledge that must have seemed invisible to the IBM decision makers who generally populated upper-middle-class East Coast residential areas.

Thus, to some extent the phenomenon of a new firm being established represents not just imperfect knowledge, but also a diverse population of individuals or economic agents. Diversity in the population of economic agents may ultimately lead to diversity in the types of firms populating the enterprise structure. These diverse firms represent experiments, based on differing visions about the value of new ideas. Just as evolutionary theory explains why diverse ideas result in a population of diverse firms, it also explains why only some of those new ideas and firms will prove viable through the selection mechanism.

Footnotes

[1] "System Error," *The Economist*, 18 September, 1993, p. 99.
[2] See Nooteboom [1994].

References

Audretsch, David B., "New Firm Survival and the Technological Regime", *Review of Economics and Statistics* 73 (1991): 441-450.

Audretsch, David B. *Innovation and Industry Evolution*. Cambridge: MIT Press, 1995.

Audretsch, David B. and Talat Mahmood, "New Firm Survival: New Results Using a Hazard Function, *Review of Economics and Statistics* 77 (1995): 97-103.

Audretsch, David B., Bert Menkveld and A. Roy Thurik, "The Decision Between Internal and External R&D," *Journal of Institutional and Theoretical Economics* 152 (1996): 519-530.

Caves, Richard E. and Michael E. Porter, "Barriers to Exit." In *Essays in Honor of Joe S. Bain*, edited by R.T. Masson and P.D. Qualls. Cambridge: Ballinger, 1976.

Coase, R.H., "The Nature of the Firm," *Economica* 4 (1937): 386-405.

Commons, John R. *Institutional Economics*. New York: Macmillan, 1934.

Costello, Neil, "Learning and Routines in High-Tech SMEs: Analyzing Rich Case Study Material," *Journal of Economic Issues* 30 (June 1996): 591-597.

Cringley, Robert X., *Accidental Empires: How the Boys of Silicon Valley Make Their Millions, Battle Foreign Competition, and Still Can't Get a Date*. New York: Harper Business, 1993.

Dosi, Giovanni, "Sources, Procedures, and Microeconomic Effects of Innovation," *Journal of Economic Literature* 26 (September 1988): 299-316.

Gilder, George. *Microcosm.* New York: Touchstone, 1989.

Groenewegen, John, "Institutions of Capitalisms: American, European, and Japanese Systems Compared," *Journal of Economic Issues* XXXI (June 1997): 333-348.

Groenewegen, John, Frans Kerstholt, and Ad Nagelkerke, "On Integrating New and Old Institutionalism: Douglas North Building Bridges," *Journal of Economic Issues* 29 (June, 1995): 467-475.

Hannan, Michael T. and John Freeman. *Organizational Ecology*. Cambridge: Harvard University Press, 1989.

Hirschman, Albert O. *Exit, Voice, and Loyalty*. Cambridge: Harvard University Press, 1970.

Hodgson, Geoffrey M. "Institutional Economics: Surveying the 'Old' and the 'New.' *Metroeconomica* 44 (February 1993a): 1-28.

Hodgson, Geoffrey M. *Economics and Evolution*. Ann Arbor: University of Michigan Press, 1993b.

Knight, Frank H. *Risk, Uncertainty and Profit*. New York: Houghton Mifflin, 1921.

Medema, Steven G. "Coase, Costs, and Coordination," *Journal of Economic Issues* 30 (June 1996): 571-578.

Minsky, Hyman, "Uncertainty and the Institutional Structure of Capitalist Economies," *Journal of Economic Issues* 30 (June 1996): 357-370.

Nelson, Richard R. and Sidney G. Winter. *An Evolutionary Theory of Economic Change.* Cambridge: Harvard University Press, 1982.

Nix, Joan and David Gabel, "The Introduction of Automatic Switching in the Bell System: Market Versus Institutional Influences," *Journal of Economic Issues* 30 (September 1996): 737-754.

Nooteboom, B., "Innovation and Diffusion in Small Firms: Theory and Evidence", *Small Business Economics* 6 (1994): 327-347.

Schumpeter, Joseph A. *Theorie der wirtschaftlichen Entwicklung. Eine Untersuchung ueber Unternehmergewinn, Kapital, Kredit, Zins und den Konjunkturzyklus*. Berlin: Duncker und Humblot, 1911.

Schumpter, Joseph A. *Capitalism, Socialism and Democracy*. New York: Harper and Row, 1942.

Wagner, Joachim, "The Post-Entry Performance of New Small Firms in German Manufacturing Industries," *Journal of Industrial Economics* 42 (1994): 141-154.

Weiss, Leonard, "Optimal Plant Scale and the Extent of Suboptimal Capacity". In *Essays on Industrial Organization in the Honor of Joe S. Bain*, edited by R.T. Masson and P.D. Qualls. Cambridge, MA: Ballinger, 1976: 126-134.

Weiss, Leonard, "Suboptimal Firm Size in Industrial Economics." *In Structure, Conduct, and Performance*, edited by D. Audretsch and H. Yamawaki. New York: New York University Press, 1991.

Williamson, Oliver E. *Markets and Hierarchies*. New York: The Free Press, 1975.

Winter, Sidney G., "Economic 'Natural Selection' and the Theory of the Firm." *Yale Economic Essays* 4 (1964): 225-272.

Table 1. Regression Results for New-Firm Survival (*t*-statistics in parentheses and results controlled for cohort effects).

	Age of cohorts				
Variable	**2**	**4**	**6**	**8**	**10**
Firm effects					
Start-up Size	0,04	0,02	0,01	0,01	0,01
	(5,99)	(5,44)	(3,65)	(4,01)	(3,75)
Capital Intensity	10,64	7,49	7,08	6,08	5,34
	(4,43)	(4,90)	(5,24)	(4,81)	(4,39)
Debt Structure	0,01	-0,02	-0,03	-0,02	-0,02
	(0,56)	(1,58)	(3,15)	(1,93)	(1,66)
Industry effects					
Average Firm Size	0,00	0,00	0,00	0,00	0,00
	(0,44)	(0,90)	(1,11)	(1,04)	(1,25)
Capital Intensity	-3,66	-3,69	-5,90	-4,91	-5,22
	(0,84)	(1,32)	(2,44)	(2,10)	(2,21)
Debt Structure	0,03	0,03	0,04	0,03	0,02
	(0,52)	(0,67)	(1,02)	(0,71)	(0,58)
Price-Cost Margin	5,27	5,16	4,36	2,37	0,73
	(2,04)	(2,80)	(2,60)	(1,51)	(0,48)
R & D	-4,17	-3,80	-2,44	-4,57	-3,99
	(0,85)	(1,00)	(0,69)	(1,35)	(1,18)
Growth Rate	-6,06	-6,60	-5,35	-2,50	0,53
	(2,36)	(3,40)	(2,94)	(1,40)	(0,29)
Entry Rate	-2,36	-2,51	-3,09	-3,55	-3,79
	(1,58)	(2,25)	(2,93)	(3,38)	(3,53)
Statistics					
No. of Survivors (out of 2017)	1730	1391	1199	1043	896
Survival Rate	0,86	0,69	0,59	0,52	0,44
Log Likelihood	-769	-1192	-1317	-1357	-1348