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Darwin, recessions and firms:
- An evolutionary perspective on firms in recessions

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Darwin, recessions and firms:

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ABSTRACT

Evolutionary theory is well suited for studying how firms are affected by recessions, but little focus has been given, both theoretically and empirically, to this phenomenon. In this paper I draw on evolutionary theory and complex system theories to develop a general model of how recessions affect firm selection. The model shows that recessions can affect selection processes in two distinct ways, one by tightening the selection environment and one by imposing changes in the shape of the fitness landscape. I then use these insights to argue that the narrow "cleansing effect"-interpretation of selection commonly used in the business cycle literature is in danger of ignoring important aspects related to selection in recessions.

INTRODUCTION

Evolutionary models are well suited for understanding patterns of change when the forces that produce change interact in non-linear and complex manners. The impact of a recession on firms is likely to be a case where we have such non-linear and complex interactions among variables that influence the outcome, and evolutionary theory should therefore be well suited to study how firms are affected by recessions.

However, little focus has been given to study how “Darwinian” firm selection is affected by recessions. Discussions of selection processes in recessions usually focus on whether it is the pre-recession most productive firms that struggle/ die or not. Selection mechanisms are thus said to “work” if it is the least productive firms that struggle in a recession (e.g. Caballero & Hammour, 1994) and “not work” if this is not the case (e.g. Nishimura, Nakajima, & Kiyota, 2005). The problem with this interpretation of selection is that it is in danger of only telling half the story of firm selection in recessions. Recessions may also, in addition to the cleansing process described above, create new variation in a population of firms which can cause selection to continue along new paths. This effect of successor selection is at the heart of Darwinian selection theory and is not captured through a narrow “cleansing process”-interpretation of selection.

In this paper I build on a general evolutionary selection theory (e.g. Aldrich et al., 2008; Knudsen, 2002) and complex system theories (e.g.Levinthal, 1997; Milgrom & Roberts, 1995) to develop a general model of how firm selection is affected by recessions. The model shows that recessions can affect selection processes in two distinct ways, one by tightening the selection environment, and one by changing the shape of the fitness landscape. The two scenarios are not mutually exclusive, and can happen simultaneously. If this is the case, and the changes in the fitness landscape are temporary, the combination of the two scenarios implies that many ex.ante fit firms may be eliminated during the crisis by the temporary increased selection forces.

The paper is organized as follows. First, I review contemporary evolutionary theory and outline a general model of Darwinian selection. Then, I complement this model with complex system theories to develop a theory of how Darwinian selection is affected by recessions. Finally, the discussion and its implications are summed up in a conclusion.

A GENERAL MODEL OF DARWINIAN SELECTION

Evolutionary thinking has a long tradition in economics (Hodgson, 1993), but it is only recently that scholars have specified a general, non-tautological evolutionary model (Aldrich et al., 2008; Campbell, 1965; Hodgson, 2002; Hodgson & Knudsen, 2010). The general model builds on the Darwinian principles of variation, selection and inheritance, and is thus as applicable to social selection (e.g. firms competing in a market) as to biological selection (Metcalfe, 1998). The first Darwinian principle, variation, is about how variety among entities in a population is created, while the principle of inheritance makes sure that the traits on which the entities differ are somewhat stable and that useful information about workable solutions is retained and passed on (Aldrich et al., 2008; Hodgson & Knudsen, 2010). The principle of selection is about how a set of entities are transformed into a new set of entities in which the frequencies of the entities are positively related to the fitness of these entities to their environment (Hodgson & Knudsen, 2006). To understand selection, we have to look to what is being selected, the unit of selection. Here, a common distinction is made between the two concepts of replicators and interactors (Aldrich et al., 2008; Hull, 1988). Interactors are the "[…] relatively cohesive entity that is actually being selected, and replicators are the entities that replicate differentially as a result of selection" (Hodgson & Knudsen, 2010:24). In evolutionary economics (Nelson & Winter, 1982), firms are viewed as bundles of organizational routines that in turn determine firms ability to compete. In the general Darwinian model firms can thus be seen as the interactors that market forces are selecting of, while the organizational routines are the replicators that replicate differently as a result of this selection (Aldrich et al., 2008; Hodgson & Knudsen, 2004; Hodgson & Knudsen, 2006; Hodgson & Knudsen, 2010; Metcalfe, 2005; Nelson & Winter, 1982). Interpreted this way, the organizational routines thus play the role in evolutionary economic processes that genes play in evolutionary biology (Nelson & Winter, 1982).

The next step in outlining the general selection model is to link the replicators and interactors to the selection environment. In the economic sphere, the selection environment can refer to both product- and factor markets (Metcalfe, 2005), and the firms that are most fit to the selection environments prosper and grow, while the least fit struggle and die. Fitness is a function of both interactor- and replicator fitness (Hodgson & Knudsen, 2004; Hull, 1988; Metcalfe, 2005), where the fitness of a replicator is the propensity "[…] to produce copies and increase the frequency of similar replicators in the population" and the fitness of an interactor is "[…] the propensity of its replicators to increase their frequency" (Hodgson & Knudsen, 2010:107).

There are two types of selection described in the literature, namely subset- and successor selection (Hodgson & Knudsen, 2006; Hodgson & Knudsen, 2010; Knudsen, 2002; Price, 1995)[1]. Subset selection refers to a situation where a subset of a population is selected through environmental interaction and is thus a simple elimination process that destroys variety (Hodgson & Knudsen, 2010). The "cleansing effect" interpretation of selection thus refers to subset selection. Successor selection, on the other hand, involves replication and contributes to the creation of new variation in a population of firms (Hodgson & Knudsen, 2006). Darwinian evolution involves repeated cycles of successor selection, where new variation is created either from imperfect replication or by existing variants being combined in new ways (Hodgson & Knudsen, 2006).

FITNESS LANDSCAPES AND COMPLEX SYSTEM THEORIES

A change from economic growth to recessions can be seen as an environmental change that cause redistributions of economic fitness across a population of firms (Metcalfe, 2005). To study fitness over different environmental states, one has to either reproduce a fitness mapping for each environmental state or include a set of environmental variables (Hodgson & Knudsen, 2010). A way to approach this first strategy is to use so called fitness landscapes. In the complex systems literature ((e.g.Kauffman, 1993; Levinthal, 1997), a fitness landscape is described as a multidimensional space where each replicator (organizational routine) of an interactor (firm) is represented by a dimension of the space and a final dimension indicates the level of fit (Levinthal, 1997). The fitness landscape will attach a fitness (or performance) value to each set of N replicators in a N+1 dimensional space (Siggelkow, 2001)[2].

The topology of the fitness landscape is determined by the degree of interdependence between replicators (Kauffman, 1993; Levinthal, 1997). The firms (interactors) compete in the market,

[1] The two selection processes are labeled differently in the literature. In this paper I follow Hodgson and Knudsen (2010) and use the terms subset and successor selection. Hodgson and Knudsen (2006) (the paper that relevant chapter in Hodgson and Knudsen (2010) builds upon) uses the term "generative selection" to describe successor selection. In the following I will refer to the original paper (Hodgson and Knudsen, 2006) but use the revised labels from Hodgson and Knudsen (2010).

[2] Most of the studies cited in this section use firm activities and not organizational routines as replicators, but the underlying logic is the same. In this paper, we follow (Nelson & Winter, 1982) and use organization routines as replicators.

and selection forces leads to the emergence of dominant combinations of organizational routines (replicators) which are represented by local peaks in the fitness landscape (Levinthal, 1997). The height of the peaks indicates the fit with the selection environment while the shape of the peak represents the level of interdependence among the replicators. Strong interdependence makes peaks steeper and also increases the difficulties associated with imitating a position in the landscape (Milgrom & Roberts, 1995). Changes in the environment may cause the height, shape or location of peaks to change, or create new peaks in the landscape (Siggelkow, 2001).

FIRM SELECTION IN RECESSIONS

With the basics in place, we can now incorporate recessions into our evolutionary model. Recessions tend to differ in their duration, intensity and specific causes, but two features are present in most recessions, namely reductions in demand and reductions in access to credit (Tong & Wei, 2008). Combining the general Darwinian selection model with insights from the complex systems literature makes it possible to deduct two distinct ways in which recessions affect firm selection. One way is through tightening the selection environment, while the other is through changing the shape of the fitness landscape. The two ways are not mutually exclusive, and can happen simultaneously. However, for illustrative purposes, I will first describe each of the two effects separately while holding the other constant before describing integrated effects of the two.

Tightening of the selection environment

A change from economic growth to recessions can be interpreted as a tightening of the selection environment that increases scarcity of demand and capital. The overall effect is that the ex. ante least fit firms struggle relatively more during the recession. If we imagine a three dimensional fitness landscape (x,y = replicators, Z =fitness), this can be described as rising "water levels" where the firms located at the lowest levels (e.g. the pre-recession least productive firms) struggle to keep afloat. The firms located at the peaks may not have their performance altered, but more of the firms not located at peaks in the fitness landscape will struggle and/or die. This scenario is thus a case of subset selection as a subset of the population (the ex. ante least fit firms) is eliminated. Hodgson and Knudsen (2006) emphasized the importance of tracing the causes of the differential survival in subset selection to the environmental interaction by specifying the selection criterion and –mechanism at work. In the case of recessions, this means specifying what causes the selection environment to tighten (e.g. reductions in demand and/or access to capital), and the selection criterion at work (e.g. productivity).

The above scenario has several implications for populations of firms. First, as described by Knudsen and Hodgson (2006), subset selection processes can lead to rapid changes in a population. Second, the elimination of the least fit firms will in turn alter the distribution of replicators in the population. If fitness is measured by productivity and recessions eliminate more of the least productive firms, the average productivity of the remaining firms will increase. The third implication is that firms located at the lower levels of the fitness landscape will have to increase their fit in order to survive. In sum, this scenario is a cleansing process (Caballero & Hammour, 1994) where the less fit firms in a population are eliminated. If the selection criterion at work is productivity and the most productive firms survive while the inefficient ones die, this will be a good thing for an economy as the average productivity levels increase.

Changes in the fitness landscapes

Recessions can also impose changes on the fitness landscape by altering the height, shape or location of peaks, or by the creation of new peaks (Siggelkow, 2001). This implies that the combinations of routines required to have fit changes. Siggelkow (2001) emphasize that the nature of how the fitness landscape is changed has important implications for the ability of a firm to adapt to the new environmental conditions. If the shape or location of a peak in the fitness landscape changes, firms can retain fit through local search as they get positive feedback from the selection environment in the form of improved performance if combinations of routines are altered in a way that increases fit. Therefore, only incremental changes are needed for a firm to regain fit. If, on the other hand, the recession reduces the height of a peak- and creates new peaks in the landscape, radical changes are needed to relocate from one peak to another. Siggelkow (2001) emphasized that great challenges are associated with this type of change as the performance of the firm will decline even though the old internal logic of the routine combinations are still in place. This is because local search will have little effect as the firms will experience more and more negative feedback from the environment when it moves away from its old position at a peak in the fitness landscape (climbs down a valley) in the search for a new peak.

Changes in the fitness landscape introduce new variation in the population of firms, and may therefore cause successor selection to proceed on a new path (Hodgson & Knudsen, 2006). After the fitness landscapes changes, new combinations of replicators determine good fit, and the firms who perform well will be the subject of imitation and replication from other firms in the population. As interconnectedness between routines creates complexities that are difficult for other firms to imitate (Lippman & Rumelt, 1982; Milgrom & Roberts, 1995), imperfect imitations are likely to happen and new mutations will be created. This again creates new variation, and can over time cause the fitness landscape to change again, although less rapidly.

If the successor selection continues on a new path as a result of the recession, the implication is that the distribution of replicators in the population of firms will change. For instance, if a recession changes the fitness landscape in a way that makes firms being selected based on financial solidity instead of productivity, the overall effect on average productivity in the population may be negative. This highlights the fact that selection processes are neither moral nor just, and can lead to “less preferable” outcomes (Aldrich et al., 2008; Hodgson, 1993; Hodgson & Knudsen, 2006; Hull, Langman, & Glenn, 2001). Also, the routines (replicators) that determine firms’ (interactors) performance are relatively stable ((Aldrich et al., 2008; Hodgson & Knudsen, 2006; Knudsen, 2002; Nelson & Winter, 1982), and it takes time for firms to change its location in the landscape. Therefore, many firms that had good fit before the recession will not be able to adapt to the changed environment fast enough. If, however, the changes in the fitness landscape are temporary, such inertia may be positive if the firms in question mange to survive long enough for this to happen. Anyhow, this effect of recessions will be ignored if a “cleansing effect”-interpretation of recessions are used.

Integrated effects

In real life, either only the selection environment is tightened or the recession both tightens the selection environment and creates changes in the fitness landscape. This latter situation has additional implications. Changes in the fitness landscape imply that firms will have to adapt to the changed environment to retain fit, while the tightening of the selection environment increases the importance of adapting to the changes fast enough to avoid being eliminated by the increased selection forces. Firms will thus have to adjust more rapidly to the changed environment than what is the case when only the selection environment changes. If the changes in the fitness landscape are temporary, the combination of the two scenarios implies that many ex.ante fit firms may be eliminated during the crisis by the temporary increased selection forces.

The above scenario show how an interpretation of selection building on general evolutionary theory leads to a quite a different view of selection processes in recessions than what would be the case if the “cleansing effect”-interpretation is used. When recessions both tighten the selection environment *and* change the shape of the fitness landscape, using the narrow interpretation of selection would make us infer that “selection does not work”, and thereby fail to identify important effects of recessions.

CONCLUSION

In this paper, I have used contemporary evolutionary theory and complex system theories to develop a general model of how selection is affected by recessions. The model shows how recessions can affect selection processes in two distinct ways, one by tightening the selection environment through increasing the scarcity of resources and one by imposing changes in the shape of the fitness landscape. The main contribution of this exercise is to highlight how a narrow “cleansing effect” definition of selection are in danger of ignoring important aspects of evolutionary processes related to successor selection. Using a definition of selection based on general evolutionary theory will remove this fallacy. This paper thus shows that a general evolutionary model should be a reasonable point of departure when studying the effect of recessions on firm selection.

Future research should aim to study the processes discussed in this paper empirically. In doing so, simulation methods from the complex system literature could be a fruitful path to follow when empirically testing hypotheses derived from the model developed in this paper.

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