

# An Agent Based Computational Economics Model for Creative Destruction

Fahad Ahmad Khan      Dr. Ivan Garibay

## Abstract

We study agent based computational economics models (ACE) that capture Schumpeterian economic dynamics [1, 10]. We diverge from previous work in that we view the economy as a complex adaptive ecosystem of firms that continuously innovate and self-organize. In particular, we posit an evolutionary artificial society with interactive and heterogeneous trade agents that are knowledge-based and that have bounded rationally. We view an evolutionary society as having major shifts in its structural organization and its network connectivity in a periodical manner i.e. the society goes through crashes and recoveries in terms of its population dynamics in a cyclical fashion. Such periodic changes in evolutionary dynamics are also termed as punctuated equilibria and the theoretical phenomenon that brings about such a change in economics is 'creative destruction' [1]. We postulate that embedding certain local properties in our agents and their surroundings would lead to the emergence of creative destruction at the macro-level. In this work we start an exploration of what these properties may be.

In the view of Schumpeter at the heart of modern economic development lay the notion of product innovation [1]. Product innovation implies the introduction of new goods and services into the market. But these innovations compete with existing products and thus a competition emerges. The nature of the competition can be argued to be survival of the fittest. This competition will result in the elimination of lesser fit products from the market. The elimination of these products will also tend force out other products from the markets which were somehow dependent upon the former for their business survival. This systemic domino effect is termed 'creative destruction'. Creative destruction leads to a dip in economic growth i.e. a period of recession but simultaneously a restructuring of the market occurs and the newer products start to establish themselves and increasing investment leads to a steady growth period which eventually stagnates as if it were have come to equilibrium. This equilibrium will remain there for some time until there is another set of innovations which will disturb this status-quo and will lead to a major restructuring of the economy. These periods of recession and restructuring followed by growth and eventually stability are cyclical in nature i.e. this pattern of economic activity is periodic in nature.

Punctuated equilibrium is an indicator of self-organized criticality in evolutionary systems. Punctuated equilibrium is the cyclical existence of stability plateaus followed by turbulent activity in terms of the population dynamics or in terms of indirect measurements directly correlated with the population dynamics i.e. the state of the population in the system going through phases of crashes and recoveries. Jain & Krishna [7, 8] and Andreas Krause [9] have developed network models of crashes and recoveries. Jain and Krishna developed an evolutionary network model based on autocatalytic sets [7, 8]. The model exhibited catastrophes and recoveries in terms of the species population dynamics and proposed their model to be an analog to certain evolutionary descriptions ecology and economics e.g. the Schumpeterian theory of creative destruction. Thurner et al. recently proposed a model for verifying the stylized fact of creative destruction [2]. They were successful in replicating punctuated equilibrium using a model whose essence was the creation of products from recombination of existing products and by imposing constructive & destructive influences on their notion of products so as to create an evolutionary selection pressure in their idea model. They developed a measure of product diversity and verified the validity of their model by using world trade data in [3]. Their validation supports the hypothesis of creative destruction.

We propose an ACE model of firms based on evolutionary dynamics that would exhibit self-organization and punctuated equilibria. Punctuated equilibrium has been argued to be a part of creative destruction processes [2, 3]. In our model there would be resource transformations in firms on the basis of a particular skills and acquired resources [5, 6]. Such an ACE model would allow us to observe economic phenomenon which include trade, gross domestic product, resource transformation dynamics, firm birth/death etc. The model essentially revolves around the process of resource transformation which essentially implies resources being created from other resources on the basis of a transformation rule aka skill. New rules are introduced into the system on the basis mutations of already existing transformation rules. Hence innovations in our system are modeled as resources resulting from the mutations of skills instead of the recombination of resources as in [2]. We hypothesize that "resource transformation on the basis of an evolving set of transformation rules will lead to punctuated equilibrium in terms of resource diversity aka product diversity". On this work we plan to test our hypothesis.

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