Facultat d'Economia i Empresa
Universitat de Barcelona

Centre d'Estudis Antoni de Capmany
UNIVERSITAT DE BARCELONA

Departament d'Història Econòmica, Institucions, Política i Economia Mundial
Av. Diagonal, 690
08034 Barcelona

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Simulating the First Industrial Revolution: An Agent-Based Model of England's Industrial Revolution according to Robert Allen

Nicola Visona (Università degli Studi di Macerata)

ABSTRACT

There are some phenomena in human history whose consequences shaped world history forever. One of these is the British Industrial Revolution, whose importance is at par with the Neolitic Revolution in changing the lives of human being that lived ever since. For the first time, human beings were able to overcome the Malthusian forces that had limited them before, marking the beginning of the modern era, and fundamentally shifting the balance of power between man and nature.

There have been numerous attempt of both explaining and modelling this phenomena. This paper attempts a novel solution to the modelization of the Industrial Revolution, based on already existing theory. To be more precise, this work presents an Agent-Based Model of the First Industrial Revolution based on the theory of Robert Allen. The aim of such endeavour is to test whether Allen's theory can produce a working simulated economy that is able to industrialize under the described conditions.

Agent-Based Models in economics simulate different economic facts and events. They do so by creating a a stylized economy with different agents programmed to interact with each others, often in different markets and with different roles. These interaction simulate an economy, and the outcome is observed without intervention. These interaction give rise to emergent properties that reproduce a stylized version of real economic phenomenon. Given the difficulties encountered when testing economic history theories due to the lack of good data, such simulations can offer an alternative,

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as the qualitative argument can be translated to agents' behavior to be parameterized later through Monte-Carlo testing.

This methodology is quite recent, as it requires strong computational power, but it widely used among different scientific fields, from meteorology and physics to anthropology and history. Regarding the economic discipline, it is mostly employed in macroeconomics and finance studies, and it has been used to study technological diffusion from the macro-prospective. This also produced a branch of ABM studies studying the historical evolution of selected business sectors, but that seems to be the maximum extent the ABMs have been used in economic history.

As such, lacking an established literature, I have decided to focus on prioritizing the reproduction of real agents' behavior described in the economic history literature over the accuracy of historical data sources. Given the complexity of the phenomenon studied and the methodology utilized, this paper is mainly focused on the role of labor costs in incentivizing innovation. To do so, we create an open economy populated by different classes of agents.

Each agent interacts in some of four different markets, either as a Seller or a Buyer. They are placed on a randomly generated space with different characteristics. Some agents can cease to exist, or reproduce. This produces a stable pre-industrial economy with minimal GDP growth. At a certain point in the simulation we add the possibility for Firms to invest a sizeable amount for transitioning into an Industrial Firm with a much higher productivity. This is possible when Firms end a turn with a depleted Stock, meaning that labor costs are high compared to the quantity produced.

We then observe how different initial condition for labor price impact differently the development of the economy: with low initial labor costs, there isn't much of a transition, and the GDP-growth remains minimal; with higher initial labor costs, ceteris paribus, we observe a sustained economic growth and a rise in output and consumption of goods.

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These preliminary results seems to indicate that Allen's theory on the causes of the Industrial Revolu-tion can be validated by emerging behavior of agents programmed with simple economic behavior, given the right conditions. High initial wages also reproduce the Engel's Pause mentioned in Allen's work, as in real wages stagnation once the industrial revolutions begin.

This can be taken as first a validation of Allen's theory on the First Industrial revolution. Additionally, various macroeconomic phenomena emerge from the agents' behavior that mimic real world economies, like inflation and business cycles, together with market crashes from overproduction. A more sophisticated version of this model could also employ more historical data for a better verification.