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Innovation by entrants and incumbents

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Abstract

We extend the basic Schumpeterian endogenous growth model by allowing incumbents to undertake innovations to improve their products, while entrants engage in more "radical" innovations to replace incumbents. Our model provides a tractable framework for the analysis of growth driven by both entry of new firms and productivity improvements by continuing firms. The model generates a non-degenerate equilibrium firm size distribution driven by entry of new firms and expansion exit of existing firms. When there is also costly imitation preventing any sector from falling too far below the average, the stationary firm size distribution is Pareto with an exponent approximately equal to one (the so-called "Zipf distribution").

JEL classification: O31; O34; O41; L16

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1. Introduction

The endogenous technological change literature provides a coherent and attractive framework for modeling productivity growth at the industry and the aggregate level. It also enables a study of how economic growth responds to policies and market structure. A key aspect of the growth process is the interplay between innovations and productivity improvements by existing firms on

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the one hand and entry by more productive, new firms on the other. Existing evidence suggests that this interplay is important for productivity growth. For example, Bartelsman and Doms [18] and Foster et al. [29], among others, document that entry of new establishments (plants) accounts for about 25% of average TFP growth at the industry level, with the remaining productivity improvements accounted for by continuing establishments (Lentz and Mortensen [43] find an even more important role for entry).

These issues, however, are difficult to address with either of the two leading approaches to endogenous technological change, the expanding variety models, e.g., Romer [54], Grossman and Helpman [34], Jones [38], and the Schumpeterian quality ladder models, e.g., Segerstrom and Dinopoloulos [59], Aghion and Howitt [5], Grossman and Helpman [33].[2] The expanding variety models do not provide a framework for directly addressing these questions.[3] The Schumpeterian models are potentially better suited to studying the interplay between incumbents and entrants as they focus on the process of creative destruction and entry. Nevertheless, because of Arrow's replacement effect (Arrow [12]), these baseline models predict that all innovation should be undertaken by new firms and thus do not provide a framework for the analysis of the bulk of productivity growth accounting for continuing firms and establishments.[4]

This paper provides a simple framework that combines these two ideas by Schumpeter and involves simultaneous innovation by new and existing establishments.[5] The model is a tractable (and minimal) extension of the textbook multisector Schumpeterian growth model. A given number of sectors produce inputs (machines) for the unique final good of the economy. In each sector, there is a quality ladder, and at any point in time, a single firm has access to the highest quality input (machine). This firm can increase its quality continuously by undertaking "incremental" R&D in order to increase productivity and profits. These R&D investments generate productivity growth by continuing firms. At the same time, potential entrants undertake "radical" R&D in order to create a better input and replace the incumbent.[6] A large case study literature on the nature of innovation, for example, Freeman [30], Pennings and Buitendam [52], Tushman and Anderson [64] and Scherer [57], documents how established firms are the main source of innovations that improve existing products, while new firms invest in more radical and "original" innovations (see also the discussion in Arrow [11]). Recent work by Akcigit and Kerr [10] provides empirical evidence from the US Census of Manufacturers that large firms engage more

[2] Klette and Kortum [41] is an exception and will be discussed below.

[3] In the expanding variety models, the identity of the firms that are undertaking the innovation does not matter, so one could assume that it is the existing producers that are inventing new varieties, though this will be essentially determining the distribution of productivity improvements across firms by assumption.

[4] Models of step-by-step innovation, such as Aghion et al. [6,7], and Acemoglu and Akcigit [3], allow innovation by incumbents, but fix the set of firms competing within an industry, and thus do not feature entry. Aghion et al. [8] consider an extension of these models in which there is entry, but focus on how the threat of entry may induce incumbents to innovate.

[5] In the model, each firm will consist of a single plant, thus the terms "establishment," "plant" and "firm" can be used interchangeably. Clearly, models that distinguish between plants and firms made up of multiple plants would be better suited to empirical analysis of industry dynamics, but would also be more complex. We are following the bulk of the endogenous technological change literature in abstracting from this important distinction. For models of dynamics of multi-establishment firms, see Klette and Kortum [41] and Acemoglu et al. [4].

[6] Continuing firms do not invest in radical R&D because of Arrow's replacement effect, but generate productivity growth as they have access to a technology for improving the quality of their machines/products and have the incentives to do so. Etro [28] provides an alternative model in which incumbents invest in R&D because, as in Aghion et al. [6,7], and Acemoglu and Akcigit [3], they are engaged in a patent race against entrants. He shows that the Arrow replacement effect disappears when incumbents are Stackelberg leaders in this race.