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Entry and exit as a source of aggregate productivity growth in two alternative technological regimes

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ABSTRACT

This paper proposes a neo-Schumpeterian model in order to discuss how the mechanisms of entry and exit contribute to industry productivity growth in alternative technological regimes. Our central hypothesis is that new firms generate gains in aggregate productivity by increasing both the productivity level and competition intensity. By assuming that firms learn about the relevant technology through a variety of sources, and by allowing a continuous flow of entry and exit into the market, our study shows that firm exit and output contraction take mostly place among less productive firms, while output expansion and entry are concentrated among the more efficient ones. The greater is the competitive pressure generated by new entrants, the higher is the expected productivity level of established firms. Overall, our analysis suggests that micro analysis is the proper complement to aggregate industry studies, as it provides a considerable insight into the causes of productivity growth.

1. Introduction

In the past few years the study of productivity issues has greatly shifted towards the understanding of the operation of micro units, with a particular emphasis on establishment- (and firm-) level reallocation. It has been shown in particular that a large percentage of industry productivity growth can be imputed to mobility of firms, with low-productivity firms losing market share (or shutting down) in favour of more productive incumbents and new entrants (Carreira and Teixeira, 2008; Foster et al., 2001). Furthermore, as shown by Aghion et al. (2009) and Falck et al. (forthcoming), the contribution of new firms to aggregate productivity growth is not only a direct one (through higher productivity than incumbents), but also indirect, via an increase in competitive pressure.

In order to provide a better understanding of the effects of new firms on productivity growth, this study proposes a neo-Schumpeterian model in which the role of firm dynamics on the evolution of a *mature* industry is extensively modelled. In a new departure from the original Nelson–Winter evolutionary industry model (Nelson and Winter, 1982; Winter, 1984), which was mostly focused on technological change, we examine how the entry and exit contribute to industry productivity growth. A central assumption in our approach is that there are two potential channels through which new firms have an impact on productivity growth: a direct one, as new firms may be relatively more productive than incumbents; and an indirect one, as new firms may generate a higher level of competition. We show that the competitive pressure induced by new firms generate sizeable firm reallocation and, as a consequence, a higher aggregate productivity. Surely, these effects would not be possible to be analyzed within a simple framework of a representative firm in which the productivity level is, by definition, common across firms.

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Another key aspect of our modelling is the full characterization of the technological regime in which firms operate.[1] As in Winter (1984), two basic cases are considered: the 'routinized regime' and the 'entrepreneurial regime'. Analytically, the difference between these two regimes is modelled via two main aspects: (a) innovative draws, which are based on firm's current productivity level—in the routinized regime—or as a function of industry's average productivity—in the entrepreneurial regime; and (b) entry and exit, with entry rates being set at a lower level in the routinized than in the entrepreneurial regime, and the productivity level of entrants based on the industry average—in the routinized regime—or on the industry's best practice—in the entrepreneurial regime. Empirically, the distinction between the two regimes has been confirmed by Malerba and Orsenigo (1996), for example, who, using patent data of six countries (US, Japan, Germany, France, the UK, and Italy), found that 19 out of 49 technological classes show patterns of entrepreneurial regime, while 15 out of 49 can be characterised as routinized regime (see also Breschi et al., 2000; Malerba and Orsenigo, 1995).

We develop a competitive dynamic setting of a *mature* industry (in a *developed market economy*) in which we have a continuing flow of heterogeneous firm entry and exit. Following the taxonomy proposed by Malerba (1992), firms can learn through 'learning by doing' and 'learning by using', on the one hand, and 'learning by searching' and 'learning from external sources', on the other. Moreover, as in Nelson and Winter (1982), firms compete with a homogeneous product through costs reduction, which is achieved through productivity improvements. In other words, in our modelling firms are focused on *process* innovation. Alternatively, one can think in terms of *product* innovation in which single-product firms compete through (vertical) product differentiation—assuming that one unit of the product contains a given amount of the single Lancasterian characteristic.[2]

In order to analyse the main properties of the model, we first introduce a non-stochastic version with no learning. Then, we discuss how the numerical results fit some key stylized facts and how the entry contributes to industry productivity growth. Our findings show that exit and output contraction take mostly place among less productive firms, while entry and expansion are concentrated among high-productivity firms. Moreover, much of the market share variation can be connected to higher competitive pressure brought in by new firms which force the least productive firms to exit. We also find that a higher entry rate of new firms is positively associated with a higher productivity level of incumbent firms.

2. Firm dynamics and industry productivity growth: some facts

Studies in several countries indicate that entry and exit flows of firms are very substantial (Caves, 1998; Geroski, 1995). In the U.K. manufacturing sector, for example, the (annual) entry and exit rates were about 6.5% and 5.1%, respectively, in the period 1974–1979. In Canada, between 1970 and 1982, the corresponding rates were 4.9 and 6.5%. Moreover, these rates vary substantially across industries—for example, the entry rate fluctuated from 3.5% to 9.6% across the U.K. (two-digit) sectors.

Entry and exit also tend to be highly positively correlated. The main reason is of course that the rate of early mortality is very high for entrants. In Canada, the hazard rate for 1971 entrants was about 10% at the end of the first year (roughly, twice as much as for the incumbent firms). In the U.K., 19% of new firms established in 1974 exited within the following 2 years, while 51% did not survive longer than 5 years (Baldwin, 1995; Geroski, 1991).

In contrast, the growth rate among successful entrants is very high. On average, surviving new plants double their initial size after 6–7 years (Mata et al., 1995), although successful entrants may take more than a decade to achieve the average size of established firms (Audretsch and Mata, 1995).[3]

The relationship between industry dynamics and firm characteristics (e.g. size, age, technological environment, and innovation) is also an important one (Caves, 1998; Geroski, 1995). The technological environment, for example, seems to impact the entry rate, while profits do not (Dosi and Lovallo, 1997; Geroski, 1994). Acs and Audretsch (1990) and Geroski (1994) have observed indeed a positive (although modest) correlation between entry and innovation rates, suggesting that a more innovative environment encourages entry. Entry also seems to be more intense in an environment providing potential entrants with greater opportunities to innovate, while the greater is the total amount of innovative activity and intensity of R&D, the higher seems to be the entry barriers.

Audretsch and Acs (1994) note, in particular, that the entry rate is lower in prototypal routinized regime industries than in industries in which the entrepreneurial regime seems to be the dominant pattern.[4]

The influence of technological environment and innovation on the ability of new firms to survive has also been examined in the literature. Audretsch (1991), using the United States data on new (i.e. created in 1976) manufacturing firms, found that an increase in the capacity of small and new firms to innovate leads to a higher survival rate, especially in the entrepreneurial regime. In the routinized regime, where the ability of small firms to innovate is relatively low, the survival rate tends to be smaller. Another important regularity is that firm's growth rate decreases with size and age, while survivability increases with the same arguments (Evans, 1987).

The technological environment influences market turbulence (or market share instability) as well (Dosi et al., 1995). For U.S. firms (1976–1980), Audretsch and Acs (1990) found that turbulence was higher in industries char-

[1] Technological regimes are defined by Nelson and Winter (1982) as the technological environment of an industry under which firms operate.

[2] For a model with product differentiation, see, for example, Marengo and Valente (2010) in this journal.

[3] An entrant is typically very small. In the United States, for example, an entrant (over the period 1963–1982) only produces in the entry year 35.2% of the incumbents' output level, on average (Dunne et al., 1988).

[4] The full definition of technological regimes is given in Section 3.