Innovation, Reallocation and Growth*

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Extended Abstract

[Paper Under Construction]

Policies that subsidize large incumbent firms, either permanently or when they face distress, are pervasive. For example, many European Governments have supported large firms with the aim of creating national champions (Owen, 2000). The majority of regional aid also ends up going to larger firms because they tend to be more effective at obtaining subsidies (Criscuolo et al. 2012). This industrial aid has also grown substantially with the onset of the Great Recession. One of the most obvious examples was the US bailout of General Motors and Chrysler in the Fall of 2008, which cost an estimated $82 billion (Rattner, 2010). The European Union also spent massive amounts on its bailouts, with their figures showing €1.18 trillion spent on state aid in 2010 alone, equivalent to 9.6% of EU GDP (European Commission 2011).

These types of “industrial policy” might encourage incumbents to undertake greater investments, increase productivity and protect employment. But such policies could also reduce growth by preventing the entry of more efficient firms and slowing down the reallocation process. This is empirically important because reallocation appears to contribute something like 70% to 80% of productivity growth in the US.¹ This is driven in large part by the entry of more efficient firms and the exit of less efficient firms. But while these papers highlight

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¹Foster, Haltiwanger and Krizan (2000 and 2006) report that reallocation, broadly defined to include entry and exit, accounts for around 50% of manufacturing and 90% of US retail productivity growth. Within this entry and exit accounts for about half of reallocation in manufacturing and almost all of the reallocation in retail. These figures will in fact underestimate the full contribution of reallocation since entrants’ prices tend to be below industry average leading to a downward bias in their estimated TFP (Foster, Haltiwanger and Syverson, 2008). As a result the contribution of reallocation to aggregate productivity growth in the US across
the importance of entry and exit in driving reallocation and productivity growth, they are silent, however, on how reallocation interacts with innovation. This is clearly critical if this type of industrial policy encourages innovation by incumbents but simultaneously discourages innovation by entrants and small firms.

This leaves open the question of how to analyze the net impact of various policies subsidizing incumbents. Such an analysis requires an empirical and theoretical framework with several features: (1) the model must incorporate meaningful firm heterogeneity in productivity, innovation behavior, employment growth, and exit behavior (including potentially between small and large, and young and old firms); (2) it must combine innovation by incumbents and by entrants; (3) it must link reallocation of resources to innovation; and (4) it must include an exit margin for less productive firms (so that the role of subsidies that directly or indirectly prevent exit can be studied). In addition, it would be highly desirable for such a model to be tractable, both to clarify the economic mechanisms at work, and to make estimation of the underlying parameters using micro data possible so that the various trade-offs can be quantitatively compared.

Figures 1-5 summarize some specific aspects of this heterogeneity—in a way that we will use in our estimation below—by showing R&D expenditures by shipments, employment growth and exit rates between small, large, young and old firms. A striking pattern is that within our sample small and young firms are both more R&D intensive and grow more. This matches the findings from a large literature investigating the relationship between firm size and innovation, which reports that younger and smaller firms tend to produce more innovations per unit of research resources. Thus, industrial policies that discourage the reallocation of resources towards newer firms might indeed be costly in that they slow the movement of R&D resources from less efficient innovators (struggling incumbents) towards more efficient innovators (new firms).

This paper develops a model with the above-mentioned features and then estimates the parameters of the model using census data on firm employment and sales matched to R&D and patents data. Our estimated model enables us to perform policy experiments that shed light on the costs and benefits of various policies that subsidize incumbent firms.

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2 As discussed in greater detail below, our sample focuses on innovative firms that are conducting R&D or patenting. Small and large are distinguished by the median employment counts in the sample by year; young and old are split by whether or not the firm is ten years old or not.

3 Cohen and Klepper (1996a) and Akcigit (2010) provide broad reference sets on this literature. For example, Acs and Audretsch (1988) demonstrate how the number of innovations increased less than proportionately in firm size than R&D expenditures in the US Small Business Administration’s Innovation Data Base of 8074 hand-coded innovations introduced in 1982. Subsequent work has employed more formal innovation production function approaches, usually with patents as the outcome variable, and examined other countries and settings (e.g., Acs and Audretsch, 1990, Tether, 1998, Lee and Sung, 2005, and Corsino, Espa and Micciolo, 2011). This literature claims that smaller companies are more creative because of the lack of the replacement-effect disincentive to innovate, less bureaucratic corporate structure, stronger individual incentives, and similar. Rosen (1991), Cohen and Klepper (1996b) and Akcigit and Kerr (2010) provide theoretical and empirical evidence on how firm size shifts the types of innovations undertaken. A related body of work considers the higher innovation rates among venture capital financed start-ups (e.g., Kortum and Lerner, 2000).
Our model builds on the endogenous technological change literature (e.g., Romer, 1990, Aghion and Howitt, 1992, Grossman and Helpman, 1991) and in particular, on Klette and Kortum’s (2004) and Lentz and Mortensen’s (2008) models of firm-level innovation. Incumbents and entrants invest in R&D in order to improve over one of a continuum of products. Successful innovation adds to the number of product lines in which the firm has the best-practice technology (and “creatively” destroys the lead of another firm in this product line). Incumbents can also increase their productivity for non-R&D related reasons. Because operating a product line requires a fixed cost, firms may also decide to exit some of the product lines in which they have the best-practice technology if this technology has sufficiently low productivity relative to the equilibrium wage. Finally, firms have heterogeneous productivity in innovation (in particular high or low productivity), and while low productivity is an absorbing state, high productivity firms can transition to low productivity. This feature both enables a richer structure of the firm-level R&D behavior and productivity growth, which proves useful in estimation, and also introduces a “selection effect”, as the composition of firms potentially differs by age. This composition effect is in general shaped by two opposing forces: on the one hand, old firms will be positively selected because low productivity firms are more likely to exit endogenously; on the other hand, old firms will be negatively selected because more of them will have transitioned to the low productivity status. The balance of these two forces will determine whether young (and small) firms are more innovative and contribute more to growth.

Despite incorporating these rich elements, which will prove important in our estimation and quantitative exercises, we show that the model is highly tractable and that much of the equilibrium can be characterized in closed form (conditional on the wage rate, which does not admit a closed form solution). This equilibrium characterization then enables us to estimate the model using the simulated method of moments (SMM) on US Census Bureau data. We construct this innovation sample through the merger of the NSF Survey of Industrial Research and Development, the NBER Patent Database, and Census Bureau operating data on employment and sales (shipments) for manufacturing firms during the 1987-1997 period. Our data platform contains over 98% of the industrial R&D conducted in the US during this period.

We compute 24 moments capturing key features of firm-level R&D behavior, shipments growth, employment growth and exit, and how these moments vary by size and age. We use these moments to estimate the 15 parameters of our model. The model performs fairly well and is able to replicate these 24 moments qualitatively and on the whole also quantitatively. In addition, we show that a variety of correlations implied by the model (not targeted in the estimation) are in the ballpark of the same correlations computed from the data. Finally, we also evaluate the model by comparing the impact on innovation of: (a) R&D tax credits and (b) the increase in the supply of skilled labor in our model with the numbers estimated in the literature using instrumental-variables methods. We find a close match in terms of estimated elasticities which is reassuring in terms of evaluating our model on previous innovation policy initiatives. These results give us some confidence that the estimated model will be useful for other counter-factual policy experiments.

The main policy experiments we perform concern the equilibrium implications of a subsidy to entrants (which is equivalent to R&D subsidy to entrants), a subsidy to incumbent R&D, and subsidy to incumbents (which is equivalent to taxing exit). We find that a 10% subsidy to entrants increases growth by about 0.2% off of a baseline of 3.3%. Some of the impact is
dissipated because this subsidy discourages R&D by incumbents due to the creative destruction effect—incumbents anticipate being replaced by entrants more quickly and thus invest less in order to expand their portfolio of leading-edge technology products. In contrast, 10% subsidy to incumbent R&D increases growth by almost 0.5%, and is thus more effective in raising growth. This is in part because a 10% subsidy to incumbent R&D is a much more significant subsidy.

Finally, we examine interventions to either keep incumbent firms from failing (by subsidizing their fixed costs) or to encourage the R&D efforts of low-type incumbent firms specifically. Both interventions are shown to reduce growth rates and to be costly. We show that similar results obtain when the subsidies are paid to large incumbent firms. These adverse effects are due to lower innovation and entry incentives in general equilibrium. Likewise, the interventions worsen the economy’s quality composition by increasing the share of low-type firms. Moreover, we find in both policies an absolute decline in the number of high-quality firms even though the policies are only intended to assist low-quality firms due to these general equilibrium effects. While the policies may keep more firms or product lines active, they retard the reallocation process to an extent that the economy’s growth is hampered.

The overall conclusion that follows from these exercises is that policies that support incumbent firms may actually be beneficial if they encourage R&D by incumbents. But if they simply subsidize incumbents or discourage them from exiting when they have low productivity, they can have substantial negative effects on innovation and productivity growth. We also develop a number of extensions documenting that both the major features of the framework we have proposed and the quantitative implications are fairly robust.

Our paper is related to a number of different literatures. First, it bridges between the literature focusing reallocation (e.g., Foster et al. 2000, 2006 and 2008) takes productivity and innovation as exogenous and the parallel literature focusing on innovation (e.g., Romer 1987, Grossman and Helpman 1991, Aghion and Howitt 1992, Jones 1995) that does not examine reallocation. Second, it builds on the prior micro-to-macro innovation literature of Klette and Kortum (2004), Lentz and Mortensen (2008), and Kogan et al. (2012). We extend this work in a number of way, in particularly by allowing for time variation in the innovativeness of firms, stochastic productivity and production and innovation labor so that we can have large firms which are no-longer innovative. These are clearly important for modelling the policy choices governments face in bailing out large national champions, which is problematic when they are no longer innovative and have suffered negative productivity shocks.

1 References


