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Public funds and local biotechnology firm creation

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ABSTRACT

A long stream of academic literature has established that public funding towards research and development matters for economic growth because it relates to increases in innovation, productivity and the like. The impact of public funding on the creation of new firms has received less attention in this literature despite theoretical constructs that support such association. In the present paper we study whether indeed there is a relationship between public research funds and local firm births in the context of the U.S. biotechnology industry. In doing so, we introduce a number of changes that strengthen the robustness of our findings when compared with existing literature. These changes include a direct measure of research expenditures and a considerably lengthier longitudinal dataset which allows us to capture a structural relationship and not a chance event. We empirically demonstrate that increases in the level of research funding from the National Institutes of Health towards biotechnology associate with increases in the number of biotechnology firm births at the Metropolitan Statistical Area level. Further, we reveal that public funds towards established firms associate with local firm births considerably more strongly when compared with funds towards universities and research institutes/hospitals. We conclude the paper with academic and policy implications of the present work that highlight the complexity of factors that underlie the creation of local firms in high technology industries.

1. Introduction

Following the Great Recession and recognizing the robustness of the U.S. knowledge economy, which sustained high employment and wages amid broad economic weakness,[1] in 2009 the U.S. government made a strategic decision to substantially increase federal funding for research and development (R&D) in high technology industries such as biotechnology (Hand, 2009; Mervis, 2009). In 2011 Ben Bernanke, the chairman of the Federal Reserve, publicly outlined the rationale and the influential role of government investments in R&D (Bernanke, 2011). Not surprisingly, interest in measuring the returns to public R&D investments quickly followed, not only in the U.S. (Basken, 2012) but also, in Europe, Australia, New Zealand and elsewhere (pg. 137 Stephan, 2012). These recent developments have revitalized a general interest towards the relationship between government funded R&D and economic growth. This relationship has been the focus of a long stream of research that has stressed the contribution of public R&D to increased innovation and productivity and has concluded that the social rate of return to public R&D investment is typically high (e.g. Beise and Stahl, 1999; Mansfield, 1991, 1995, 1997; Narin et al., 1997; Salter and Martin, 2001; Tijssen, 2002; Toole, 2012). Such findings have, in turn, supported continuing public R&D spending over time.

The conceptual underpinnings of such work are also strong. Investments in R&D tend to be risky, mainly due to limited knowledge appropriability and uncertainty of outcomes (Arrow, 1971). Such characteristics can discourage private parties from investing in R&D because the expected private rate of return is low. In fact, the social rate of return from R&D investments often outweighs the private rate (Griliches, 1992; Hall, 1996). Consequently, governments may be able to correct this market failure by funding

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[1] We subscribe to the definition of the knowledge economy in Powell and Snellman (2004): "production and services based on knowledge-intensive activities that contribute to an accelerated pace of technological and scientific advance as well as equally rapid obsolescence".

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R&D and increase the odds of socially desirable outcomes (Arrow, 1962; Nelson, 1959).[2]

This sort of argument for government intervention relies heavily on a complete understanding and accounting of the benefits from public R&D funding. Yet, one potential benefit from public R&D funding, firm creation, has received relatively limited attention in the academic literature despite the strong link between firm creation and economic growth (Van Praag and Versloot, 2007; Wennekers and Thurik, 1999). Indeed, there are good theoretical reasons to expect that public R&D funding may encourage firm creation. For instance, increased R&D expenditures can expand the knowledge base developed in universities and other research institutions and a part of it can be commercially exploited through firm spinoffs (Chachamidou and Logothetidis, 2008; Lockett and Wright, 2005).[3] New firms may also be formed to capitalize on non-appropriated knowledge (e.g. Acs et al., 2009; Audretsch and Keilbach, 2007).

In this study we focus on the question of whether publicly funded R&D expenditures lead to firm births in knowledge-intensive industries and in particular in biotechnology. A number of studies have examined the relationship between R&D expenditures and firm births but most have not delineated the sources of funds that support R&D (Bade and Nerlinger, 2000; Goetz and Morgan, 1995; Karlsson and Nyström, 2011; Kim et al., 2011; Kirchhoff et al., 2007; Woodward et al., 2006). Accordingly, our knowledge on the impact of public R&D funding on firm creation is limited.

In our review of the literature we have identified only two studies that have focused on the impact of public R&D funding on the creation of biotechnology startups: Chen and Marchioni (2008) and Zucker et al. (1998). Both studies find a positive relationship between indicators of publicly funded R&D activity and local biotechnology firm births. Our study adds to the findings of these two studies and introduces a number of methodological and measurement improvements. For instance, these previous studies do not distinguish between the type of organization that receives the public funding and performs the R&D. Here, we recognize the potential for differential efficiencies between industrial and academic R&D organizations on the rate of firm creation (Bade and Nerlinger, 2000; Karlsson and Nyström, 2011) and examine the impacts of public R&D funds directed to universities, private firms, research institutes and research hospitals separately. The two previous studies have also measured the impact of federal R&D outlays on firm creation in the biotechnology industry for rather short periods of time (up to two years). Here, we extend the period of analysis to 18 years (1992–2010) recognizing the inherent long cycles involved in R&D funding, knowledge development and potential firm creation from such new knowledge. As well, instead of proxies of R&D intensity employed in the two previous studies (a life sciences index and a count of faculty members with grants) we use a more direct and sharper measure of R&D activity, namely, the dollar amount of R&D funding awarded to universities, private firms, research institutes and research hospitals.

We focus on firm births in the biotechnology industry for several reasons. First and foremost, because the biotechnology industry is a core part of the knowledge economy and understanding how it grows is important. Second, because the industry is a heavy recipient of federal research funds (Lazonick and Tulum, 2011), it is a fertile ground for our investigation.[4] Third, because of the close linkage between basic biotechnology research and commercial applications, there is potential for a strong relationship between the level of R&D activity and firm births (Argyres and Liebeskind, 1998; McMillan and Narin, 2000). Fourth, because the biotechnology industry exhibits a strong tendency to cluster in narrow geographies (Audretsch and Stephan, 1996; Powell et al., 2002; Zucker et al., 1998), biotechnology firm births tend to concentrate in regions with large venture capital pools, specialized labor pools, and anchor institutions, like large biotechnology firms and universities (Audretsch and Stephan, 1996; Powell et al., 1996, 2012; Zucker et al., 1998). These are exactly the types of institutions and geographies that a large share of public biotechnology R&D investment is typically directed to. For these and other reasons, we expect that if a relationship between public funding of R&D and firm creation exists, it should be possible to detect in the biotechnology industry.

For our empirical analysis we construct a rich dataset that includes all R&D funds from the largest funding source, the National Institutes of Health (NIH), directed towards biotechnology research from 1992 up to 2010. We complement this dataset with information about biotechnology firm births, venture capital investments and other relevant variables from Thomson's Financial SDC Platinum Database and other sources.

We organize the rest of the paper as follows: In the next section we briefly discuss the biotechnology industry and some of its characteristics that make it attractive for our analysis. In Sections 3 and 4 we review the relevant literature and develop our theoretical expectations on the effects of federal R&D monies on biotechnology firm births. In Section 5 we describe our econometric model and estimation procedures, and in Section 6 we review the data we use. In Section 7 we present the estimation results and in Section 8 we discuss how we test the robustness of those results. Finally, in Section 9 we offer concluding comments, implications for policy and suggestions for further research.

2. The biotechnology industry

The scientific origins of biotechnology can be traced back to the advancements of molecular biology and related fields in the 1950s (Kenney, 1986). However, biotechnology as an industry began to develop after the discovery of the basic technique for recombinant DNA in 1973 from Stanley Cohen of Stanford University and Herbert Boyer of University of California – San Francisco.

The fundamental discoveries in genetic engineering led to an ever-increasing rate of innovation. By the mid-1980s, a large number of novel products and processes were being pursued in a variety of industries (Mowery and Nelson, 1999). For instance, in the pharmaceutical industry regulatory proteins (e.g. human insulin and growth hormone), vaccines, antibiotics and monoclonal antibodies for diagnostic and therapeutic uses, were early targets. In agriculture, animal health products and growth promotants, and genetically engineered plants (e.g. plants resistant to herbicides, insects, diseases, and drought), were also broadly pursued. Improved amino acids, enzymes, vitamins, lipids, were the main targets in the specialty chemicals industry. And, R&D activities extended in various other industries, from food processing to environmental remediation.

The development of waves of biotechnology innovations and associated competencies, such as genetic engineering, bioprocessing, genomics, proteomics, metabolomics and others, has since continued and has led to an ever-expanding range of potential

[2] Salter and Martin (2001) and Chaminade and Edquist (2006) elaborate that additional considerations, besides the market failure arguments, are often in place before the government intervenes in the market place.

[3] Data from the Association of University Technology Managers (AUTM) suggest that over the last twenty years more than 9000 university spinoff firms were created based on knowledge and intellectual property developed at major research universities in the U.S.

[4] Biotechnology is not a heavy recipient of public R&D investments only in the US, but across the world (for instance see Dohse (2000).