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Why buy what you can get for free? The effect of foreign direct investment on state patent rates

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ABSTRACT

Research has shown that foreign direct investment (FDI) encourages economic growth at the state level. We also know that knowledge spillovers, measured via patent counts, contribute to economic growth. Using an instrumental variable approach, this paper demonstrates that FDI increases patent rates in US states, thereby providing a link for the mechanism through which FDI impacts growth. Moreover, we find that FDI in neighboring states has just as strong an impact on patent rates, giving further credence to the notion that knowledge can spill across state borders.

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1. Introduction

A considerable body of research demonstrates that foreign direct investment (FDI) can lead to economic growth via a number of channels. These include an increase in the stock of capital, transfers of knowledge, technology, and management techniques, or even through increased competition as domestic firms streamline and upgrade their own technology and production processes to compete with their foreign rivals. To date, however, there has yet to be a study that demonstrates a direct relationship between inward FDI and technological growth at the economy-wide level. Such a finding would be important considering that the literature has come to the conclusion that technology is the primary factor in sustaining long-run economic growth. Utilizing patent data from US states and a new stock measure of FDI, this paper finds evidence that inward FDI increases the stock of knowledge at the US state level, even upon controlling for the potential endogeneity of FDI. Furthermore, we find that FDI from neighboring states is as effective in increasing this knowledge as foreign firms that locate within a state's borders. In light of the recent state competition for foreign firms, these results suggest the question: why buy what you can get for free?

2. Literature review

2.1. The knowledge spillover

A determining factor in the location choice of FDI has been the presence of agglomeration economies in a particular locale (Pelegrin and Bolance, 2008). Marshall's (1920) early work focused light on three externalities that helped give rise to such agglomeration: labor, input, and knowledge/technological spillovers. Our focus is on the creation of knowledge spillovers, and in this regard there are two competing frameworks. The MAR externality model (so called because of the combined works of Marshall (1920), Arrow (1962) and Romer (1986)) emphasize how knowledge spillovers are mostly generated within a particular industry. On the other hand, Jacobs (1969) stresses that the more varied the industrial mix in a region, the larger the knowledge spillovers that are produced. While this debate boils down to the relative importance of urbanization versus localization economies, in both views knowledge spillovers have a role to play.

Recent work has focused on the geographical area in which knowledge spillovers can occur. Rosenthal and Strange (2008) focus on concentrations of college educated workers and find that while firms benefit from the resulting agglomerative forces, this impact attenuates rapidly with distance. Similarly, Fu (2007) shows that spillovers in Boston are contained within tight geographic areas. While both papers identify attenuating agglomeration effects, there is no direct evidence of knowledge spillovers, although they likely are a component of the impact.

Callois (2008) argues that physical proximity is partially offset by background proximity of the innovators themselves. Thus, innovating firms need to not only be near one another, but also be near firms from other industries as well in order to maximize spillover potential. A similar result is found in Agrawal et al. (2008), who find a tradeoff between the geographic and co-ethnic (or social) closeness of innovators. In line with this, while Lobo and Strumsky (2008) find that the clustering of innovators is important, they question whether

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the social network by which innovators interact plays a significant role in creating knowledge spillovers.

2.2. Knowledge, growth, and spillovers

The role of knowledge spillovers in economic growth can be traced back to the early models of Solow (1956) and Swan (1956), which placed technological advancement at the center of economic growth. The models predicted that in the long-run, growth is determined solely by the rate of technological progress, which is exogenously determined. Romer (1986) allowed for knowledge spillovers that were the unintended result of investment decisions made in a perfectly competitive market. Such externalities increased the stock of knowledge in proportion to the stock of capital resulting in a production function void of diminishing returns. Later, models emerged which linked the evolution of technology through the intentional decisions of firms to undertake research and development (R&D) in the quest for monopoly profits.[1] The key to generating endogenous growth via these models resides in the assumptions made concerning the properties of the technology and knowledge. Grossman and Helpman (1991) show that if knowledge and technology are assumed to be private goods, growth eventually stops. However, if knowledge is non-rival and at least partially non-excludable, the benefits of the increase in knowledge spillover to others and endogenous growth occurs.

Jaffe (1986) provides evidence that knowledge does indeed meet the requisites to generate endogenous growth. He finds that firms performing research in high R&D areas gain more patents per dollar and earn a higher return on their investment in R&D. Furthermore, Jaffe et al. (1993) show through the use of patent data that knowledge spillovers tend to occur at the state and SMSA level and dissipate slowly over time into neighboring areas. Further evidence of knowledge spillovers has been discovered from university research to corporate patents at the state level (Jaffe, 1989), from "star" academicians to products in development or on the market in the California biotechnology industry (Zucker et al., 1998) and from universities to high technology innovations in the United States (Varga, 2000), Spain (del Barrio-Castro and Garcia-Quevedo, 2005) and Sweden (Andersson et al., 2009).

2.3. Patents as knowledge

There has been some disagreement in the literature concerning the proper measure of technological change. According to Acs et al. (2002) these measures have involved inputs (R&D expenditures), intermediate outputs (patents), or measures of final innovative output which represent the use of patents in a final commercial product. However, after utilizing the two most commonly used measures—patents and the use of patents in a final commercial product—in a regression-based comparison at the MSA level, the authors conclude that "the measure of patented inventions provides a fairly good, although not perfect, representation of innovative activity. This supports the use of patent counts in studies examining technological change" (p. 1080).

In response to the importance placed by endogenous growth models on the role of R&D expenditures, Sedgley (2006) collected data on US patents issued since 1851, capital stock estimates, and human capital estimates in order to calculate the contribution of each to the growth in real per worker gross domestic product since World War II. He finds that knowledge (using patents as a proxy) accounts for between 11% and 50% of postwar growth in the US.[2]

2.4. FDI and spillovers

Most research to date has looked for indirect spillovers from FDI by examining its effect on either the economic growth or productivity of an economy. For developing countries Borensztein et al. (1998) find that FDI is growth enhancing when the host country has a minimum level of human capital. Xu (2000), studying the effect of US multinational corporations on host countries' total factor productivity growth, also finds that sufficient level of human capital is required for the host country to gain. Ford et al. (2008) find that FDI contributes more to growth in US states than domestic investment, provided the state has a sufficiently high level of human capital (measured as the percent of the population having at least a 4 year college degree).

One direct test of the effect of FDI on knowledge spillovers comes from Branstetter (2006) who, using firm level data, finds US inventors' citations to the patents of a particular Japanese firm increase with the FDI presence of the firm. He also finds that firms that increase their FDI presence in the US are more likely to cite US patents. Using four measures of FDI (total number of affiliates, total number of acquired affiliates, total number of R&D/product development facilities, and total counts of greenfield (new plant) affiliates) Branstetter deduces that cites of Japanese patents by US inventors' is highest in greenfield affiliates because these new firms locate in the US to exploit some superior technological advantage over existing US firms. Japanese cites of US patents, however, are highest with respect to R&D/product development facilities, which presumably are designed to exploit technological developments in the US.

Three mechanisms for the transfer of knowledge from foreign to domestic firms have been proposed in the literature. The first conduit is a direct effect whereby the foreign firm licenses a particular technology, formally sets up supplier networks, or engages in subcontracting arrangements (Driffield, 2001). Less formally, transfers of knowledge can arise through everyday contact with local suppliers, general observations by local firms, and the movement of knowledge as workers leave foreign-owned firms for those owned domestically (Hubert and Pain, 2001). Finally, and most prominently, technological knowledge is transferred through backward linkages where foreign firms provide training and technical assistance to their local suppliers (Narula and Marin, 2003). Numerous examples of this type can be found in Moran (2001) where "multinationals often provide technical assistance to their suppliers in order to raise the quality of their products or facilitate innovation. They help suppliers with management training and organization of the production process, quality control, purchase of raw materials, and even finding additional customers" (Javorcik, 2004, p. 608).

In addition to helping suppliers meet their stringent quality standards, Craig and DeGregori (2000) posit that "a firm which has had its technology borrowed and improved upon when the firm is still potentially innovative and a leader in research is better able to borrow the technology back than if it were borrowed at a time when it was less innovative or may have fallen behind in other ways" (p. 404). They estimate that the US presence of Honda in 1982 accelerated technological change for Ford and Chrysler at a rate of almost 3% faster for the following decade.

[1] These include the horizontal technological progress models of Romer (1987, 1990) and the vertical technological models of creative destruction of Aghion and Howitt (1992).

[2] Patent counts cannot capture the entirety of knowledge spillovers occurring within a state. Moreover, patents are more likely to be the outcome of knowledge spillovers in certain industries (such as biotech or pharmaceuticals), meaning patents may overstate the relative amount of knowledge spillovers for a particular state should the state have a large clustering of these particular industries. The use of state fixed effects in our empirical model should dampen any potential impact this may have.

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