Research Policy 42 (2013) 517–528

Contents lists available at SciVerse ScienceDirect

Research Policy

journal homepage: www.elsevier.com/locate/respol

National scientific capacity and R&D offshoring

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ARTICLE INFO

Article history:
Received 7 June 2011
Received in revised form 9 July 2012
Accepted 9 July 2012
Available online 9 August 2012

JEL classification:
F21
O19
O32

Keywords:
R&D offshoring
Foreign direct investment in R&D

ABSTRACT

This paper presents new evidence regarding the role of national scientific capacity in driving patterns of R&D offshoring using a larger and more comprehensive dataset than has hitherto been used and applying it in a gravity model framework. Our results unambiguously support the importance of inventor country scientific capacity in attracting offshored R&D. As expected, the home country's scientific capacity is also found to play a positive role. We find that in fact, on average, firms source technology from less technologically advanced nations, suggesting that firms offshore to access niche skills.

1. Introduction

Until relatively recently, it was widely considered that R&D is offshored primarily to support overseas production and adapt products and processes for the local market. To a considerable extent, this belief stemmed from the observation that most offshoring originates from firms based in R&D intensive economies and occurs in technological fields in which the multinational enterprise (MNE) manifests a revealed technological advantage (Cantwell, 1995; Patel and Vega, 1999; Le Bas and Sierra, 2002). This in turn casts doubt on the potential for countries to attract foreign R&D by augmenting national scientific capacity.

Direct evidence regarding the role of host-country scientific capacity on the other hand is mixed. Some survey data indicate that accessing technological capacity and skills are high on managers stated considerations in determining the location of offshored R&D (Florida, 1997; Thursby and Thursby, 2006; Lewin et al., 2009), while others conclude that the desire to tap into host-country technological expertise is relatively unimportant (Molero, 1998; Ambos, 2005). Quantitative studies which estimate revealed preference report mixed results. Guellec and van Pottelsberghe (2001) find that offshored R&D exhibits a negative relationship with aggregate host country R&D intensity, though a recent study by Belderbos et al. (2009) find academic specialization is positively associated with attracting foreign research. In apparent contradiction to both these results Kumar (1996) finds that the R&D activity of American MNE affiliates is positively related to host-country R&D intensity, but not to higher education activity (Granstrand, 1999; Hegde and Hicks, 2008 also report mixed results).

One factor underpinning this ambiguity is that most studies examine the offshoring activity of a sample of firms, typically in one industry or from a given home (or host) country. This is problematic since, as many scholars of R&D offshoring have observed, conclusions depend heavily on the sample of firms analyzed (Patel, 1995; Granstrand, 1999; Belderbos, 2001; Le Bas and Sierra, 2002). In many cases, sampling begins by identifying a group of the largest, most innovative or most internationalized firms. This sampling approach introduces considerable scope for selection bias. For example, there is evidence that the globalization strategies of large and medium firms are systematically different (Belderbos, 2001). Where patent data are used to measure R&D offshoring, they almost universally come from one single patent office, despite the known biases that this introduces (as noted by Guellec and van Pottelsberghe, 2001; Le Bas and Sierra, 2002; Picci, 2010). In addition to these potential sampling issues, few past authors looking at the role of host country technological capacity have incorporated the scientific capacity of the firm's home base in their models – despite the established role of home country attributes in driving R&D offshoring. Home country technological capacity determines the existence of leading MNEs and their capacity to manage and benefit from globally dispersed R&D assets (Vernon, 1966; Patel and Pavitt, 1988, 1991; Le Bas and Sierra, 2002; Song and Shin, 2008; Song et al., 2011).

This paper presents new evidence regarding the role of national scientific capacity in determining patterns of R&D offshoring which seeks to avoid these problems. We use data aggregated to the

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http://dx.doi.org/10.1016/j.respol.2012.07.003

national level from 26 OECD countries over an extended period (1985–2006). Our indicator of R&D offshoring is based on a count of priority patent applications in which the applicant is domiciled in a different country from the inventor. This new 'global' measure provided by de Rassenfosse et al. (2011),[1] effectively eliminates selection and sampling issues that arise in the analysis of the patenting activity of a sample of firms or applications to a single office.

We consider three indicators of national scientific capacity of the home and host country: the extent and quality of postgraduate research education, output in basic science, and the caliber of research universities. In acknowledging that leading 'offshorers' come from high technology capacity countries, we assess whether firms offshore to the 'next best' countries. To do this, the analysis builds on the work of Guellec and van Pottelsberghe (2001)[2] and Picci (2010) who first proposed the gravity approach as a means to investigate the role of geographic and cultural proximity. However, their gravity models do not include measures of national scientific capacity. We also control for research costs which is important since host countries with lower quality R&D inputs are also likely to be lower cost, either due to market factors or compensatory government policies. To assess the influence of cost our model includes a measure of researcher wages and, additionally, a newly constructed measure of R&D tax incentives that are available to foreign-owned firms.

Our results provide unambiguous support for the importance of host country scientific capacity in attracting offshored R&D. As expected, home country scientific capacity is also found to play a statistically significant role. In fact, we observe the seemingly paradoxical result that, on average the originating country exhibits a higher level of scientific capacity than the host. By tapping into niche expertise across a globally dispersed frontier of scientific knowledge, offshoring may contribute to technological competitiveness even if in aggregate terms the host country exhibits lower scientific capacity. An interesting corollary of the findings is that policies which augment scientific capacity are predicted to increase offshoring by national firms while also making the country more attractive to offshored R&D from foreign firms. Finally we also provide novel evidence that tax policy may play a role in the R&D location decision. This finding is important because cost reducing subsidies are a popular policy mechanism through which governments may hope to attract offshored R&D.

The paper is organized as follows: the next section draws on the existing literature to develop a framework for describing the forces which are driving the globalization of R&D. Section 3 describes recent trends and patterns based on our global measure of offshoring. Our empirical model and data are described in Section 4 and results are presented in Section 5. In Section 6 we conclude by noting key policy implications and suggestions for future research.

2. Theoretical framework

R&D offshoring is driven by the need to adapt products and processes to local markets (called market-seeking R&D) as well as the desire to source the world's best technology at the lowest cost (known as technology-seeking R&D). Since market seeking R&D is underpinned by the need for proximity to key markets or manufacturing assets (Cordell, 1973; Ronstadt, 1978; Dunning, 1994), national scientific capacity is not expected to influence its location. Past scholars have revealed a strong relationship between affiliate sales and R&D (Mansfield et al., 1979; Lall, 1979; Hakanson and Nobel, 1993). Some more recent studies using international patenting data have failed to identify a significant relationship between aggregate foreign direct investment (FDI) and R&D offshoring (Belderbos et al., 2009; Picci, 2010).

Technology-seeking R&D aims to source the best technology at the lowest cost for use in the firm's global operations (see Dunning, 1994; Cantwell, 1995; Florida, 1997; Kuemmerle, 1997). Technology-seeking R&D is undertaken to capture spillovers from technology intensive host countries, high caliber research universities (Granstrand, 1999; Kuemmerle, 1999a,b; Thursby and Thursby, 2006; Belderbos et al., 2009), and highly skilled individual scientists (Ronstadt, 1978). The technological capacity of MNE home base is also increasingly acknowledged as playing a crucial role in driving technology seeking offshoring. An MNEs home country is a central determinant in firm technological advantage (Patel and Pavitt, 1988, 1991; Cantwell, 1989; Le Bas and Sierra, 2002) and in turn, the technological capacity of a firm's home base is critical to absorb and integrate technology acquired abroad (Song and Shin, 2008; Song et al., 2011). A contrasting hypothesis is that a deficiency in home country technological capacity can underpin the motivation to offshore (e.g., Kumar, 2001). However, since offshoring in fields that the MNE is not strong at home is rare, this view is not well supported (Patel and Vega, 1999; Le Bas and Sierra, 2002). Recent research by Lewin et al. (2009) indicates that a mismatch of supply and demand of research inputs in the home country can potentially play a role even in large technologically advanced countries. While there is some debate regarding the mechanism of influence, these theories all highlight that home country technological capacity plays an important role in driving offshoring behavior.

The role of arbitraging costs between locations was widely speculated in the early literature (e.g., Mansfield et al., 1979; Lall, 1979). Host countries with less extensive scientific capacity and R&D input quality are likely to be lower cost, due to either market factors or compensatory government policies. The few existing quantitative studies indicate that labor costs may be important (Kumar, 2001; Athukorala and Kohpaiboon, 2010). However, surveys asking respondents direct questions about the decision to offshore indicate that R&D labor costs are of second-order to skill quality (Thursby and Thursby, 2006; Lewin et al., 2009).

Related to costs, fiscal incentives continue to be of considerable interest to governments, despite limited evidence as to their effectiveness. An exception is Bloom and Griffith (2001) who find that the weighted average offshore (foreign) tax-price has a large impact on domestic R&D. This suggests that fiscal incentives play an important role in the location decision. Nonetheless, the only two studies which considered the impact of foreign tax policy on offshored R&D directly have experienced problems finding an exogenous measure of foreign tax policy with sufficient variation to identify an effect (Billings, 2003; Athukorala and Kohpaiboon, 2010).[3] These two studies use data on the offshoring activity of US firms alone.

The ease with which people in the two countries are able to communicate with each other is also believed to influence the decision to offshore R&D, particularly for technology-seeking purposes. Ease of communication is mediated by the existence of a common language and geographic proximity. However, one might conjecture these factors being negatively correlated to the need to perform adaptive market-seeking type R&D. Several authors have

[1] I am grateful to the authors for providing this.

[2] Guellec and van Pottelsberghe first proposed the gravity approach, using data from the USPTO to assess the role of geographic proximity and common language in determining flows between countries. Their paper also reports a separate estimate of a more traditional model of onshored and offshored R&D (aggregated by partner country) which includes national R&D intensity.

[3] Billings (2003) uses a simple binary indicator of 'special incentive' and Athukorala and Kohpaiboon (2010) use an ordinal indicator of tax policy that is time invariant (representing the situation in the year 2000) and which therefore does not reflect the multitude of policy changes over their study period.