Research Policy xxx (2014) xxx–xxx

Contents lists available at ScienceDirect

Research Policy

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

Dynamic complementarities in innovation strategies

James H. Love[a,*], Stephen Roper[b], Priit Vahter[c,a]

[a] Enterprise Research Centre and Aston Business School, Aston University, Birmingham B4 7ET, UK
[b] Enterprise Research Centre and Warwick Business School, University of Warwick, Coventry CV4 7AL, UK
[c] Faculty of Economics and Business Administration, University of Tartu, Tartu 51009, Estonia

ARTICLE INFO

Article history:
Received 17 December 2012
Received in revised form 25 April 2014
Accepted 19 May 2014
Available online xxx

Keywords:
Innovation strategies
Dynamic complementarities
Open innovation
Ireland

ABSTRACT

Using a panel of Irish manufacturing plants over the period 1991–2008 we test for dynamic complementarities in the joint use of internal R&D and external knowledge sources. We find little evidence, either from considering successive cross-sectional waves of comparable surveys, or in terms of the strategy switch choices of specific plants, that there has been a systematic move towards the joint use of internal and external knowledge in innovation. We then test formally for the presence of complementarities in the joint use of internal R&D and external innovation linkages. In static terms we find no evidence of complementarity, but in dynamic terms find evidence that strategy switches by individual plants towards a more 'open' strategy are accompanied by increased innovation outputs.

1. Introduction

The strategic innovation literature increasingly recognizes that a combination of internal and external knowledge sources is a key element of a successful innovation strategy (Arora and Gambardella, 1990, 1994; Veugelers and Cassiman, 1999). More broadly, recent studies have stressed the importance of 'open innovation' as a means of enhancing innovation performance (e.g. Chesbrough, 2003). As it is frequently described, one key aspect of the open innovation approach is to take advantage of external as well as internal knowledge sources in developing and commercializing innovation, so avoiding an excessively narrow internal focus in a key area of corporate activity. In this context, effective boundary spanning between the internal and external aspects of innovation becomes central to a successful innovation strategy. Several studies also provide direct evidence of complementarities between firms' internal activities – generally the firm's intra-mural R&D – and boundary-spanning knowledge linkages (e.g. Cassiman and Veugelers, 2006; Love and Roper, 2009).

If there are indeed widespread complementarities between internal and external knowledge sources in innovation, one would expect this to be reflected in firm behaviour through time. We examine two aspects of this. First, is there any evidence of a systematic shift of firms towards more joint use of internal R&D and external innovation linkages? And second, where individual firms do move towards an innovation strategy involving both internal and external sources, is this accompanied by increased innovative activity? In order to consider these issues it is helpful to use panel data, preferably involving a lengthy time period. By contrast, the majority of work on internal/external complementarity uses cross-sectional data, which cannot identify how innovation strategies change through time, nor what the effects of these changes are on firm performance.[1]

In assessing the value of adding external knowledge sources to existing internal knowledge we make use of the concept of dynamic complementarities. Two discrete activities are (Edgeworth) complementary if adding one activity increases the returns from doing the other. This implies that the benefit of adding a new activity depends not simply on what the firm currently does, but on what it did in the past: it concerns adding something to an existing strategy. This can therefore only be determined by considering the effects of a specific change in strategy by a given enterprise relative to the option of sticking with the existing strategy. This is an intrinsically dynamic analysis, and so needs information on strategy choice decisions through time. In order to examine these questions in a dynamic context we use a unique dataset which comprises an unbalanced panel of Irish manufacturing plants which covers six successive three-year periods spanning the years 1991–2008. By analysing the strategy choices and innovation performance of these

* Corresponding author. Tel.: +44 1212043001.
E-mail addresses: j.h.love@aston.ac.uk (J.H. Love), stephen.roper@wbs.ac.uk (S. Roper), Priit.Vahter@ut.ee (P. Vahter).

[1] Exceptions to this are discussed in the sections which follow.

http://dx.doi.org/10.1016/j.respol.2014.05.005

plants through time we are able to shed light on the two key issues identified above.

We therefore make two contributions to the literature. First, we are able to examine, over an extended period of time, whether there is any evidence of a change in the tendency for firms in Ireland to jointly use internal and external knowledge in innovation. We do this both on average by comparing representative cross-sectional samples of establishments at different points in time, and secondly by examining how manufacturing plants change their innovation strategies through time. No other dataset we are aware of is able to examine these changes over such a long time period using comparable data. Second, we are able to investigate the relationship between strategy choices and innovation performance using the concept of dynamic complementarities. This represents a significant advance over the static complementarity analysis usually employed in innovation studies (Cassiman and Veugelers, 2006; Schmiedeberg, 2008; Love and Roper, 2009) which typically infer the complementarity between internal and external knowledge sources from cross-sectional comparison of strategy choices across different firms, rather than the same firms through time.

We find little evidence of a systematic shift towards a more 'open' innovation strategy in Irish manufacturing, at least in terms of the joint use of internal R&D with external innovation linkages. Further, our analysis of static complementarities suggests that there is no evidence of (strict) complementarity between internal R&D and external innovation linkages. However, when dynamic complementarities are considered, there is systematic evidence that switching to the joint use of internal and external knowledge sources is accompanied by increased innovation outputs. We end by considering the implications of these findings for the literature on innovation strategies and for policy.

2. Complementarity in theory and practice: a simple typology of innovation strategies

Innovation depends crucially on firms' ability to absorb external knowledge, combine it with their own proprietorial knowledge and develop new market offerings (Chesbrough, 2003; Roper et al., 2008). The strategic challenge is how firms can best organize the sourcing, codification and exploitation of the internal and external knowledge and informational resources to maximize and sustain innovation (e.g. Zahra and George, 2002; Davila et al., 2005). An important element in this process is the identification and effective harnessing of knowledge complementarities between different activities inside and outside the boundaries of the firm.

Achieving the optimal mix between internal knowledge generation and external knowledge sourcing for innovation suggests a strategic choice. However, the major theoretical approaches do not provide unequivocal guidance on the issue of the optimal internal/external mix. In the transactions cost literature, for example, the firm's minimand is cost, although issues of appropriability, contract compliance and the potential for opportunism and hold-up need also to be considered (Love and Roper, 2002). Because of its emphasis on the relative costs of performing operations in-house or externally, almost inevitably the transaction cost approach tends to regard these alternative scenarios as substitutes; the emphasis is on deciding which of two alternative governance structures is least costly in transaction cost terms.

It has been argued that the TCE approach is relatively poorly equipped to deal with innovation, because of its inability to deal adequately with processes which involve learning (Foss and Klein, 2010; Barge-Gil, 2013). However, the other major conceptual approach in the management literature, the resource-based view (RBV) or competences approach is somewhat ambivalent on the merits of internal versus external organization. The emphasis of the RBV on heterogeneous and inimitable assets, resources and attributes appears to imply an emphasis on in-house development and the avoidance of the potentially risky external route, where competitors might learn to copy at least some of the basis of the firm's competitive advantage. On the other hand, the same approach acknowledges the possible benefits from firms sharing technological or other capabilities via strategic alliances, joint ventures and knowledge sharing agreements (Barge-Gil, 2013). Theory does not necessarily provide unambiguous hypotheses, therefore providing a clear role for empirical research.

Schmiedeberg (2008) suggests several practical reasons why internal and external R&D activity might be expected to be complementary. First, the absorptive capacity dimension of internal R&D described by Cohen and Levinthal (1989) facilitates the search for external innovation partners by providing the basis on which to assess their input quality. Second, high absorptive capacity facilitates coordination and communication between internal and external partners, making joint projects more likely to be successful. In addition, the presence of internal R&D makes a particular firm not only more visible as a potential innovation collaboration partner, but also more likely to be perceived as an attractive partner by other firms. Some internal R&D capacity is therefore useful for three reasons: first, to permit scanning for the best available external knowledge; secondly, to enable the efficient absorption and use of this knowledge; and thirdly, to help in the appropriation of the returns from new innovations (Griffith et al., 2003).

Empirical studies of complementarities in internal and external innovation activity yield mixed results. An early study, Arora and Gambardella (1990), finds that the strategies of linkages with external parties are complementary among large firms in the biotechnology industry, a finding echoed for patterns of external networking in German (but not UK) manufacturing by Love and Roper (2009). Using German CIS data, Schmiedeberg (2008) tests explicitly for complementarities between internal R&D and externally contracted R&D, but finds little evidence to support the hypothesis of complementarity. In a study of 269 Belgian manufacturing firms, Cassiman and Veugelers (2006) test for complementarities in 'make and buy' strategies for R&D with respect to subsequent innovation performance. They conclude that internal R&D and external knowledge acquisition are complementary innovation activities, but that the degree of complementarity is sensitive to other elements of the firm's strategic environment, such as the use of 'basic' R&D. Other recent studies explore in more detail different aspects of contingencies between internal and external innovation inputs. For example, in a study of 83 pharmaceutical firms, Hagedoorn and Wang (2012) find that the level of in-house R&D investment matters critically: internal and external R&D are complementary where in-house R&D investment is high, and substitutes where it is low. Lokshin et al. (2008) find similar results in their study of Dutch manufacturing firms. They also find evidence of complementarity of internal and external R&D, but with a positive effect for external R&D only where firms have sufficient absorptive capacity in terms of internal R&D investment. Finally, Grimpe and Kaiser (2010) conclude that outsourcing R&D is made more effective by the presence of both internal R&D and formal R&D collaborations.

2.1. A typology of strategies

In order to explore the existence or otherwise of complementarities between internal R&D and external collaborative linkages in innovation, we can identify four 'states' or strategies employing different combinations of internal R&D and external linkages:

1. No R&D or external linkages (NEITHER)

Please cite this article in press as: Love, J.H., et al., Dynamic complementarities in innovation strategies. Res. Policy (2014), http://dx.doi.org/10.1016/j.respol.2014.05.005