



## Knowledge diffusion and innovation policies within the European regions: Challenges based on recent empirical evidence

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### ARTICLE INFO

#### Article history:

Received 7 May 2010

Received in revised form 30 June 2012

Accepted 23 July 2012

Available online 11 August 2012

#### Keywords:

Localised knowledge flows

Innovation policy

European regions

### ABSTRACT

This article builds upon the empirical results concerning localised knowledge spillovers in order to highlight some policy implications within the European regions. The analysis emphasises the role of the regional innovation policies as supporting the institutions which generate knowledge and learning. However, it appears that the search for universal policy tools is unrealistic. The empirical literature stresses indeed a variety of regional features. In this perspective, we argue that original strategies have to be built in order to cope with the various dilemmas faced by regional innovation policies, concerning in particular the best way to enhance and exploit public/private, intra/inter-firms, intra/inter-industries and local/global knowledge flows. Such specific strategies require having an accurate knowledge on the local features and on the comparative positioning of the concerned region compared to others. Improving data and indicators to diagnose and monitor regional innovation is therefore presented as a key issue for the policy makers.

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### 1. Introduction

In his 1994 article, Metcalfe identifies two main profiles in technology policies: (i) those which take the possibilities of innovation as given, and thus seek to stimulate innovation by reducing the cost of R&D activities or by increasing the profitability of private innovation; (ii) those which seek to expand these opportunities.

This paper, based on the results of the empirical literature devoted to knowledge spillovers, places itself in the second perspective. This supposes that innovation policy is far more than a justification for R&D subsidies. We argue that, in a knowledge-based economy, taking into account the sources, paths and the underlying mechanisms of knowledge diffusion, the innovation policy's uppermost role is to install the variety of mechanisms which facilitate the capture and assimilation of local and external knowledge.

One of the main results of the Economics of Innovation is indeed that the technological knowledge is not only an output of the R&D activity, but also its principal input. A wide range of empirical studies have shown the positive impact of R&D spillovers on

firm productivity,<sup>1</sup> introducing different kinds of external inputs into the production function or cost function. Their results are confirmed by the more recent estimations (Sena, 2004; O'Mahony and Vecchi, 2009; Autant-Bernard et al., 2011). Thus, empirical literature emphasises the relevance to focus on knowledge flows, and provides evidence consistent with the hypothesis of positive knowledge externalities. The spatial dimension stressed in some of these studies is of primary interest for regional policy makers.

Since the contribution of Marshall (1920), spatial proximity is believed to ease firm interactions and knowledge diffusion. More recently, the Economic Geography and Endogenous Growth models (Lucas, 1988; Martin and Ottaviano, 1999; Baldwin and Martin, 2005) explain the differences in regional growth paths from geographically constrained knowledge externalities at the roots of increasing returns and localised economic growth. The spatial dimension of knowledge externalities finds empirical support with the Geography of Innovation,<sup>2</sup> based on the pioneering works of Jaffe (1989), Acs et al. (1991), Jaffe et al. (1993), Feldman (1994), Audretsch and Feldman (1996, 1999), Acs et al. (1997), Almeida and Kogut (1999).

On the whole, it is generally argued that the existence of local knowledge flows favors the innovative capacity, and drives the

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<sup>1</sup> See Sena (2004) for a review.

<sup>2</sup> The term is taken from the title of Feldman (1994) which stands as a major reference in this empirical literature.

regional economic dynamics. At the same time however, public policies conceived to form a Silicon Valley type technology area have shown their limitation and are now widely considered as utopian (Maggioni, 2002; Rallet and Torre, 2007). Thus, even though the theoretical and empirical literature confirms that regional innovation policies have a role to play (Tödtling and Trippl, 2005; Howells, 2005; Laranja et al., 2008) and that they are at a key intervention level to support the institutions which generate knowledge and learning (Morgan, 2004), a main question remains: how to concretely impact on knowledge flows and on their geographic dimension? The answer is not obvious and is at the heart of this article.

Our analysis builds upon the empirical results of the Geography of Innovation, concerning the localised knowledge flows, in order to highlight some policy implications within the European regions. This econometric literature is interesting for regional science and innovation policies. Indeed, the results of applied econometrics provide comparisons between various institutional contexts. Furthermore, the observation levels are generally government-defined areas,<sup>3</sup> which is highly relevant for regional policy makers.

Taking into account the main initial contributions on American and European data, this paper is more specifically based on the latest studies. Many of them take place as a result of the European programme devoted to Intangible Assets and Regional Economic Growth (IAREG).

Recently, the measurement of the geographical dimension of knowledge externalities has been significantly improved, introducing some more complex processes of knowledge diffusion and using individual data along with new spatial econometric tools. This refines the modeling of externalities in knowledge production functions and enables to test for spatial auto-correlation (Acs et al., 2002; Fingleton and Lopez-Bazo, 2006; Autant-Bernard et al., 2008).

The geographic dimension of knowledge externalities – whether they flow from science to industry, remain intra-industrial or are intra-firm – is confirmed by the empirical literature. This result gives an important place to interventions at the regional level which is adequate to exploit the geographic externalities. However, latest studies show that proximity is not a sufficient condition for knowledge flows to occur. Many constraints other than those due to geographical distance can hinder the transmission of knowledge between the actors of innovation, so that specific actions have to be carried out to favour knowledge flows within regions. In addition, the empirical studies also clearly show that, even where they exist, the effects of proximity are never exclusive, and interact with effects far more remote nationally and internationally. This may give rise to other important stakes for the regional dynamics of innovation concerning the positioning of the region within the more global mechanisms of knowledge transfer and innovation networks.

These new results of the literature on the geography of innovation are discussed in Section 2. In Section 3, arguments are provided justifying the implementation of regional public policies and giving them rationales. While the main difficulties to define and implement regional innovation policies are also stressed, different situations are identified, that may require public actions in order to favour innovation at the local level. Section 4 describes more precisely some of the relevant instruments which can be used in order to practically implement the previously designed policies and create the conditions for their effectiveness. Lastly, summary and concluding comments are provided in Section 5.

## 2. The geography of innovation: new empirical evidence

Empirical studies, including the latest analyses, highlight the influence of spatial proximity on knowledge flows and interpersonal relationships, indicating that geographical proximity is a prerequisite for learning and innovation (Autant-Bernard and Massard, 2009). In addition, the recent advances provide us with new evidence that shows potential for the design of regional innovation policies.

The spatial range of the positive effects of knowledge flows is observed to vary substantially depending on the institutional context as well as on the technological field (Peri, 2005). Therefore, the existence of organisational frontiers may prevent knowledge flows. Such frontiers are particularly obvious between public research and private firms, but they also occur between firms (Autant-Bernard et al., 2011). The variety of knowledge may also explain how it unequally flows through space. For example, depending upon the nature of the specialisation and upon the maturity of the industry, the sharing of embodied knowledge may hinder knowledge flows. The evidence suggests that the diffusion of tacit knowledge and its absorption necessitate more than a simple closeness. The diffusion of tacit knowledge also relies on effective interpersonal interactions among a variety of actors. Thus, to play a significant role, the geographical proximity effects have to be combined with other dimensions, such as organisational, institutional or cognitive proximity. A main conclusion of the empirical studies considering the different aspects of proximity is that the geographical proximity, per se, is neither a necessary nor a sufficient condition for learning to occur. Nevertheless, it generally facilitates interactive learning by strengthening the other dimensions of proximity and thereby contributes to the positive effects of local knowledge externalities (Boschma, 2005).

Basically, these recent advances have not only allowed us to better quantify knowledge flows and their spatial extent but also to qualify them, resulting in a more complex picture of the role played by space, as well as a better understanding of the sources and mechanisms of knowledge diffusion. The main results of these recent studies are detailed in the following paragraphs.

### 2.1. A more accurate assessment of the magnitude of spatial knowledge flows

Following the seminal work by Jaffe (1989) and Jaffe et al. (1993), the two main methods used to assess the spatial dimension rely on the knowledge production function on the one hand, and on patent citations on the other. Recently, both approaches have benefited from methodological advances and have been applied to various contexts (different countries, different industries, and different time periods) allowing more precise inferences on the magnitude and spatial dimension of knowledge spillovers to be drawn.

#### 2.1.1. Empirical evidence from patent citations

Bergman and Usai (2009) survey the empirical studies using patent citations as proxies of knowledge flows, from Jaffe et al.'s (1993) contribution on data provided by the US Patent Office (USPTO) to more recent studies on European data, principally based on data provided by the European Patent Office (Lesage et al., 2007; Paci and Usai, 2009), or combining American and European data (Lukatch and Plasman, 2003; Criscuolo and Verspagen, 2006). The main result of this literature is to highlight the importance of geography on knowledge flows between patent-inventors.<sup>4</sup>

<sup>3</sup> States or metropolitan areas in the US, regions or departments in France.

<sup>4</sup> Thompson and Fox-Kean (2005) have shown that part of the local effect observed in patent citations would, in fact, disappear once narrow patent classifications are used instead of the relatively broad one used in Jaffe's (1989) methodology. The

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