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Mobility of knowledge and local innovation activity

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ABSTRACT

This paper studies the diffusion of knowledge and its consequences for local innovation production. In a common framework, we analyze the geographic reach of different channels of knowledge flows that thus far have been studied separately in the literature. To jointly estimate these flows, we develop and apply novel econometric techniques appropriate to the nature of the data. We find that geographic along with technological proximity to be more essential to the operation of market than to non-market channels of knowledge flows. External accessible disembodied knowledge has a strong positive effect on local innovation production that is larger than that of embodied knowledge.

1. Introduction

Economic growth is driven by innovation activity carried out locally as well as by the ability of a region to learn from external technological achievements (Romer, 1986; Grossman and Helpman, 1991).

The contribution of knowledge flows on the shape of the geographical distribution of innovative and economic activities and consequently on inequality among regions and countries (Saxenian, 1994; Swann et al., 1998; Verspagen, 1999) has motivated scholars to document them and study their boundaries. A voluminous literature has progressed on separate avenues, however, depending on how knowledge flows are inferred.

Most notably, the patent-citation literature, initiated by the seminal work of Jaffe et al. (1993) and followed by numerous subsequent studies (Branstetter, 2001; Peri, 2005; Mancusi, 2008), traces-out technological learning via citations of patents.[1]

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[1] A parallel literature infers knowledge flows via citations of research papers (Belenzon and Schankerman, 2013). The latter channel, however, captures knowledge diffusion mostly within academia. Furthermore, citation of papers reflects scientific rather than commercial aspects of technological knowledge.

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The principal assumption there is that a citation from a patent to another indicates that inventors of the latter patent knew and used the former.[2]

Knowledge flows can be also mediated by market mechanisms. A rich research avenue, the trade-growth literature, infers technological learning by analyzing trade flows (Grossman and Helpman, 1991; Coe and Helpman, 1995; Eaton and Kortum, 2001; Keller, 2002b; Caselli and Wilson, 2004). Imports of foreign capital and intermediate goods allow a recipient country to learn from the R&D-, or 'technology'-content embodied in the traded good. Consequently, merchandise trade acts as an important conduit of market-based knowledge flows across regions. The trade-growth literature, however, has been reluctant to incorporate information on patent citations and technological space of the interaction units. An alternative channel of knowledge diffusion is that of foreign direct investment (FDI). There is an extensive literature on the mechanisms through which the inflow of FDI enhances the flow of technology across frontiers (Glass and Sagg, 1998; Borensztein et al., 1998; Xu, 2000; van Pottelsberghe de la Potterie and Lichtenberg, 2001).[3]

Another recent strand of research studies the trade of patented ideas as a vehicle of market-generated knowledge flows (Spulber, 2008). Technology transfer from a firm to another can take place via the market of intellectual property.[4] Businesses, for example, buy patents to use the technology covered by the patent, which could be vital for their production, and the buyer's willingness-to-pay depends on the technological knowledge contained in the patent (Anton and Yao, 1994). Further, the buyer of a patent can develop connections with the seller in order to acquire the "how-to" knowledge to implement the patented technology.[5] Research in this field has documented evidence on national and international transfers of intellectual property rights and spread of technological knowledge in a number of countries using historical data (Nicholas, 2010; Moser, 2011; Burhop and Wolf, 2013). A recent stream of research by Serrano (2010, 2011) develops models of costly technology transfer and renewal in the market for innovation to quantify possible gains from trading patents as well as costs of adopting technology in the market for patents, while a strand of research infers knowledge flows by studying the flows of academic licensed patents using proprietary data of a (small) number of US universities (Mowery and Ziedonis, 2015).

Finally, a separate branch of literature documents evidence on learning via the mobility of highly skilled personnel. The focus on job moves of patent inventors is based on the assumption that ideas and knowledge are embodied in the minds of individuals (Feldman, 2000) and, consequently, job movements enable an inventor to take advantage of knowledge – not only codified, but also tacit – accumulated by other inventors in inventor's past jobs and share it in later jobs. A number of studies, in this literature, have extensively investigated the migration of inventors as a potential channel of market-generated knowledge diffusion. For example, Kim and Marschke (2005) explore the linkages between inventors' mobility and knowledge flows in the nanotechnology sector confirming that the mobility of inventors enhances the citations across patents of firms that the inventor was previously employed. Similar conclusions are also drawn by Agrawal et al. (2006), who document that knowledge flows to an inventor's prior location are approximately 50% greater than if the inventor had never lived there, suggesting that social relationships, not just physical proximity, are important for determining flow patterns.[6] Rather than studying citations exchanged between inventors, Giuri and Mariani (2013) focus on the interactions between inventors that were important for the development of a patent using survey data for European patent inventors.

This paper aims to jointly study the relative mobility of most notable channels of knowledge flows that thus far have been studied by separate literature avenues in one common framework and assess their individual consequences for local innovation production in the US. In doing so, we use newly constructed data and develop and apply appropriate estimation techniques.

More specifically, in this paper, we jointly study the geographic stretch of knowledge via four channels namely, patent citations, trade of goods, trade of patents, and inventors' mobility, and assess the importance of each channel for knowledge diffusion and local production of innovation. With our approach, we are able to contribute to important discussions in the literature, for instance, whether the generation mechanism of knowledge flows, i.e., market-based flows (traded patents, inventors' mobility, trade of goods) versus non-market spillovers (citations), matters for the geographic stretch of knowledge diffusion (Audretsch and Stephan, 1996). We are also able to quantify and compare the relative importance of disembodied knowledge that operates via trade of patents and citation exchange versus embodied knowledge in inventors and goods for local innovation production (Grossman and Helpman, 1991; Rivera-Batiz and Romer, 1991). The study of different channels of knowledge diffusion within a simple, common framework of analysis, compatible with different literature traditions, consists the first contribution of this paper.

[2] The awareness of the citing patent inventor about the cited patent (i.e., the amount of information about the content of the cited patent actually reached the possible unaware citing inventor) has raised criticisms about how much actual knowledge patent citation flows indeed capture (Alcacer and Gittelman, 2006; Harhoff et al., 2008). A crucial factor is that citations in patents are the results of a highly mediated process, which involves the patent inventor, the patent attorney and the patent examiner. Despite the limitations, studies (Jaffe et al., 2000) have shown that patent citations can be used as a proxy of knowledge flows as 40% of the inventors surveyed indicated that they learned about the cited invention either before or during the development of their invention.

[3] According to this literature, knowledge disseminates through various channels namely, imports of capital goods by the subsidiaries of multinational corporations (MNCs), R&D flows carried out in the parent country, movements of employees/managers across countries, and the links between MNC subsidiaries and local firms.

[4] In addition to increasing the rate of innovation as the inventor can just sell the patent to a specialized producer and focus his own efforts on the next invention, patent transactions improve the allocation of technology in an economy. As knowledge production is highly concentrated in space (Audretsch and Stephan, 1996), the market of patents facilitates the stretch of patented ideas in space as potential buyers can purchase innovations without having to re-invent them.

[5] A concern, however, in using patent trades, as a potential channel of technological knowledge flows, is that companies could also buy patents for strategic, e.g., defensive (to help defend the patents the company already owns by acquiring similar technology), negotiating, and blocking purposes. Disentailing, however, the reason of a patent transaction, i.e., whether it is for technology acquisition or pure strategy, is not easy as there is no information available.

[6] See Miguelez et al. (2010) for an excellent survey of the literature and Ganguli (2015) for recent evidence on immigration of researchers and diffusion of ideas.