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Benefiting colleagues but not the city: Localized effects from the relocation of superstar inventors

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ABSTRACT

In this paper I examine episodes in which superstar inventors relocate to a new city. In particular, in order to assess whether the beneficial effects of physical proximity to a superstar have a restricted network dimension or a wider spatial breadth (spillovers), I estimate changes in patterns of patenting activity following these events for two different groups of inventors: the superstar's close collaborators, and all the other inventors in a given urban area, for both the locality where the superstar moves to and for the one that is left behind. In the case of collaborators, I restrict the attention to patents realized independently from the superstar. The results from the event study register a large and persistent positive effect on the collaborators in the city of destination, as well as a simultaneous negative trend affecting those still residing in the previous location. In the long run, these effects translate into an increased difference between the two groups of about 0.16 patents per inventor. Conversely, no city-wide spillover effect can be attested, offering little support to place-based policies aimed at inducing a positive influx of top innovators in urban areas.

Theories of knowledge spillovers are predicated on a variety of social mechanisms, which all explain – across different settings – the occurrence of information exchange through individual interaction. Among these mechanisms, geographic proximity occupies an ambiguous position. On the one hand, spatial vicinity can be thought as a factor that is complementary to the process of knowledge creation, which occurs through formal professional collaborations within or between organizations. On the other hand, proximity may also favor the diffusion of new ideas among spatially close, but professionally unrelated workers. The latter scenario entails agglomeration externalities, a circumstance that can explain the endogenous co-location of individuals and firms across space, with far-reaching policy implications.

Despite the relevance of this issue, economic research does not offer a clear description and supporting evidence of how geographical proximity drives the emergence and diffusion of economically valuable new ideas. In order to isolate local knowledge spillovers, in this paper I analyze episodes in which "superstar" inventors – those in the top 5% of the patent distribution – relocate across North American or European cities. In particular, I examine the impact of these events over time on the "residual" patent output (patents not coauthored with the superstar) of four groups of inventors: that is, the individuals who belong to the network of patent collaborators of the superstar and those who do not, for both localities of departure and destination. In addition, I analyze how these effects vary between superstars' coworkers and other kinds of collaborators, with the relative position of the moving star in the patent distribution, across technological fields, and by the geographical extent of the move (whether it involved moving across the Atlantic, and in what direction).

The main findings from this event analysis can be summarized as follows. The relocation of superstar inventors appears to follow periods of time when both groups of collaborators – those in the locality of destination, and those left behind – experience similarly increasing trends of their residual patent production. Following the event, however, the trend relative to the colleagues left behind experiences a reversal, which manifests itself with a one year lag (this might reflect the lag of the R&D-to-patenting process). Conversely, the residual patent output of the newly neighboring colleagues keeps increasing for a few years to eventually remain stable. Thus, following the event the difference between the two groups increases – relative to the baseline year – up to about 0.16 extra yearly patents per inventor in favor of the benefiting network. The main qualitative result is robust to a variety of patent measures, and it appears stronger if coauthors from either locality have also been coworkers of the moving superstar, if the latter belongs to the top 1% of the patent distribution, and in the Electro-ICT and mechanical sectors.

Nevertheless, there seems to be no strong evidence in favor of a similar effect on the patent output of all other inventors in both cities involved. Instead, the results indicate that superstars move towards

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cities that, relative to their city of departure, experience a slightly stronger increase in their total patent output in the years before and after the event, but not an increase in the overall quality of such patents (as measured by patent citations) or in the average patent production of their inventors. Taken together, these findings indicate that knowledge spillovers, if they exist, appear largely confined within the circle of one inventor's close connections; by the terminology introduced in this paper, local knowledge spillovers do not seem to be very much *external* to the superstar's network. As a consequence, the evidence in favor of "big push" type of place-based innovation policies – realized on the expectation that attracting few highly creative individuals may result into a wider equilibrium shift in local innovativeness – is mixed.

This paper builds on the tradition of economic studies searching for geographically localized externalities associated with R&D activity. In their renown seminal work, Jaffe et al. (1993, JTH) show how patent citations – which are seen as the "paper trail" of knowledge spillovers[1] – tend to come from the same urban area as the cited patent. In subsequent research, however, JTH are notoriously criticized by Thompson and Fox-Kean (2005, TF). The latter show that, upon "zooming in" to finer technological classes, the result by JTH vanish, suggesting that the originally evidenced correlation reflects the spatial distribution of economic and technological activity. By contrast Breschi and Lissoni (2009, BL), in a contribution that anticipates some of the ideas explored in this paper, show that the results by JTH become smaller in magnitude – but are still economically significant – when controlling for the "social distance" (in the network sense) between the two inventor teams behind both citing and cited patents, even within narrow technological sector as per the analysis by TF.

In addition to BL, other studies about knowledge spillovers incorporate a social or network dimension. Agrawal et al. (2008) show that while reducing either the network or the geographical distance between inventors increases the probability of citing a patent, these two factors seem to be substitutes rather than complements in knowledge production, which is consistent with the results presented in this paper. In another study, Agrawal et al. (2010) attest that in "company towns" patent citations are concentrated within the same firm, suggesting an organizational dimension of spillovers. Breschi et al. (2017) study both the "diaspora" and "brain gain" effects at work among expatriate inventors, that is respectively the role of ethnic and home country ties in determining patent citations. In this paper, social networks shaped by co-patenting relationship are interacted with geography, with the aim of disentangling the spatial and social dimensions of knowledge flows.

Studies of knowledge spillovers typically differ by the geographical scope of the knowledge flows they examine. Some analyses focus on cross-country spillovers (Branstetter, 2001; Keller, 2002; Singh, 2007; Mancusi, 2008), while others delve into smaller geographical units, like states and regions (Audretsch and Feldman, 1996; Almeida and Kogut, 1999; Singh and Marx, 2013; Bloom et al., 2013). In this paper, I consider the city or metropolitan area as the relevant spatial dimension of knowledge spillovers. In this respect, a notable precursor is the study by Moretti (2004), who shows that plant productivity is predicted by the share of college-educated workers from other industries in the city where the plant operates. Furthermore, the analysis of firm-to-firm R&D spillovers by Lychagin et al. (2016) provides an interesting take on the determination of spillovers' geographical scope: by estimating models featuring effects of external R&D that decay with distance, they argue that spillovers are largely confined within small areas.

The central identification problem faced by all these researchers is how to separate genuine geographic externalities from other common factors that are shared within the localities of interest. In fact, this methodological issue is not specific to the analysis of knowledge spillovers, as it is shared by all urban and trade economists searching for general agglomeration economies (of which knowledge spillovers is usually thought to be one main determinant). A celebrated approach, employed by Greenstone et al. (2010) in their analysis of the effect of large plants on local productivity, is to exploit tail events affecting "winning," but not similar "losing" localities, and compare the outcomes of the two places against one another. This paper is based on a similar idea: specifically, I compare the patenting outcomes of selected groups of inventors between places that "receive" and places that "lose" superstar inventors. While the superstar's decision to move might be endogenous to the characteristics of the two groups, the machinery of the event study analysis allows to evaluate if their pre-event trends are sufficiently similar to one another and, if they are, how do they compare with the post-event dynamics.

This paper is also related to all those studies examining the economics of innovative "superstar" professionals, with a focus on very successful inventors and academics. Perhaps most famously among these studies, the work by Azoulay et al. (2010) provides evidence on the role of superstars in stimulating the intellectual production of other scientists, by documenting the negative consequences of a superstar's "extinction" on his network of strict collaborators.[2] Oettl (2012) extends their analysis and methodology to what he calls *mavens*, that is, scientists of below-stellar productivity but of high "helpfulness" towards other scientists. In another related and influential study, Waldinger (2011) finds however more mixed evidence of star effects following the exile of Jewish top academics from Nazi Germany. There is also a growing interest in the analysis of the migration patterns of superstar inventors. In particular, recent work has assessed the role of marginal tax rates in determining the location choice of top inventors, both between U.S. cities and states (Moretti and Wilson, 2014, 2017) and countries (Akcigit et al., 2016).

The remainder of this paper is organized as follows. Section 1 provides a discussion of the conceptual framework underlying the paper. Section 2 introduces the data and describes the mobility pattern of highly skilled inventors. Section 3 outlines the empirical framework for the analysis of superstar relocation events. Section 4 presents and discusses the empirical results of the analysis. Finally, Section 5 is dedicated to some conclusive remarks.

1. Conceptual framework

In his classical taxonomy of knowledge spillovers, Griliches (1979) distinguishes between *horizontal*, *vertical*, and *technological* spillovers, which respectively operate between firms that are related in product markets, in supply chains or in technological domains. Scholars occasionally amend this list by adding *geographic spillovers*, on the grounds that the easier communication due to spatial proximity expedites the exchange of ideas. However, listing spatial proximity as separate from other types of spillovers can be argued as misleading. Reduced communication costs, in fact, affect all forms of interactions that lead to the emergence of spillovers, across and within industries. The role of geography is perhaps best interpreted in terms of different *agglomeration* forces which, since Marshall (1890), are typically invoked in order to explain the emergence of productivity advantages due to co-location. In what follows, I interpret the classification of agglomeration forces by Duranton and Puga (2004), which builds upon the original Marshallian analysis, in a context of knowledge or – more specifically – patent production that involves both ordinary inventors and superstars.

The first agglomeration force is *sharing*, which is generally about the advantages from the use of common inputs by multiple firms or agents. In the context of knowledge production, different inventors might

[1] This definition is based upon one famous critical statement by Krugman (1991), according to whom "knowledge flows […] are invisible; they leave no paper trail by which they may be measured and tracked."

[2] The identification strategy employed in their paper, however, is not capable to provide an unambiguous test of the interaction between collaboration with a superstar and common spatial location (see the discussion at pg. 577 of the article).