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Do spinoff dynamics or agglomeration externalities drive industry clustering? A reappraisal of Steven Klepper's work

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JEL codes: B15, B52, O18, R11

Keywords: Klepper, spinoff dynamics, agglomeration economies, Marshall, industry cluster, evolutionary economic geography

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“I still think geography is the most under-researched area. All these beliefs that have come about, I don't think they are well-founded, so I think there are great opportunities there.”

interview with Steve Klepper recorded by Serguey Braguinsky on May 20, 2013

Abstract

Klepper's theory of industry clustering based on organizational reproduction and inheritance through spinoffs challenged the Marshallian view on industry clustering. The paper provides an assessment of Klepper's theoretical and empirical work on industry clustering. We explore how 'new' his spinoff theory on industry clustering was, and we investigate the impact of Klepper's theory on the economic geography community. Klepper's work has inspired especially recent literature on regional branching that argues that new industries grow out of and recombine capabilities from local related industries. Finally, the paper discusses what questions on industry location are still left open or in need of more evidence in the context of Klepper's theory.

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1.Introduction

Why do many industries cluster in space? Economic geographers have been preoccupied with this question for more than a century (Rosenthal and Strange 2004). Till recently, there was an influential view in economic geography that industry clustering was due to Marshallian externalities, based on local knowledge spillovers, labour market pooling and specialized suppliers, after the seminal work of Marshall (Marshall 1920). Once a new industry started to develop in a region, these local externalities were believed to stimulate further firm entry and growth in clusters. Klepper challenged this Marshallian thesis by providing an alternative theory of industry clustering based on organizational reproduction and inheritance through spinoff formation (Klepper 2007a, 2010, 2011; Buenstorf and Klepper 2009; 2010). His own studies found support for his spinoff thesis, and little support for the Marshallian thesis.

The first objective of the paper is to explore how ‘new’ Klepper’s spinoff theory on industry clustering was. This requires an effort to look at relevant literatures that predated Klepper’s ideas and provided a context in which his ideas unfolded. In the 1980s, economic geographers adopted a product/industry life cycle approach to explain the rise of clusters like Silicon Valley (Norton 1979). Their work remained firmly grounded in agglomeration thinking in which new industries were believed to emerge in diversified urban regions, while industries would benefit from Marshallian externalities at a later stage of their life cycle. At about the same time, many scholars linked spinoff activity to cluster formation in high-tech industries (Dorfman 1983; De Jong 1987) but they did not depart from Marshallian thinking. There were scholars in the 1990s who attributed entry activity over the industry life cycle to spatial clustering of an industry (Arthur 1994; Hannan et al. 1995). Sorenson et al. (Sorenson and Audio 2000; Stuart and Sorenson 2003) made explicit that no agglomeration economies are needed to explain industry clustering, as clustering increases not only entry rates but also exit rates. Klepper’s achievement was that he turned these building blocks into a comprehensive theory of spinoff dynamics and heritage to explain industry clustering.

The second objective is to assess the impact of Klepper’s new theory on the community of economic geographers, including urban and regional economists. We present a citation analysis of Klepper’s work in economic geography journals, and we discuss the influence of Klepper’s work in economic geography. For one thing, his work has become a main pillar in a new strand of literature in economic geography, that is Evolutionary Economic Geography, which depicts the evolution of the uneven spatial distribution of economic activity as the outcome of contingent, path dependent processes (Boschma and Lambooy 1999; Boschma and Frenken 2006; Martin and Sunley 2006). A recent spinoff of Klepper’s work is the regional branching literature which argues that regional diversification is rooted in local capabilities, in which new industries grow out and recombine capabilities from related industries (Neffke et al. 2011b; Rigby 2013; Essletzbichler 2015).

The third objective is to discuss issues on industry location that are still left open, unanswered or in need of more evidence in the context of Klepper’s theory. We discuss the role of industry specificity, such as the extent to which industries might differ with respect to the

relative importance of spinoff dynamics versus agglomeration economies (De Vaan et al. 2013). We discuss the possible role of local related externalities on firm survival which received little attention in Klepper's own empirical work on industry clustering (Boschma and Wenting 2007). And we explore more in detail the possible impact of Marshallian externalities on the entry and survival of spinoffs in clusters, like the role of local institutions and knowledge networks that were paid little attention to in Klepper's work.

The structure is as follows. Section 2 describes the context in which Klepper developed his theory of industry clustering based on the spinoff process through organizational inheritance. In Section 3, we make a short assessment of how well his core theory was received by the community of economic geographers that had published on industry clustering since more than a century. We claim that his idea of related entrepreneurship, though not part of his core theory, has been taken up in economic geography in particular, and which has led to a growing body of literature on related diversification in regions. In Section 4, we present a critical appraisal of Klepper's work on industry clustering, and we discuss promising research avenues that use Klepper's work as a source of inspiration. Section 5 concludes.

2. Industry clustering: Marshall versus Klepper

To assess the contributions of Klepper to the literature on industry clustering, we discuss a number of relevant literatures that predated his own work on this topic. These concern: (1) literature on Industry Life Cycle (ILC) and location of industries; (2) early work on spinoffs and the location of high-tech industries; (3) regional entry models in an ILC framework; and (4) entry and exit analysis of industries and their location. This enables us to determine more precisely how 'new' Klepper's spinoff theory on industry clustering actually was.

In the late 1970s and 1980s, economic geographers adopted a product/industry life cycle approach (Abernathy and Clark 1978; Gort and Klepper 1982) to describe the rise and fall of regions in general, and industry clustering in particular (Norton 1979; Markusen 1985; Chapman 1992). It was hypothesized that new products giving birth to new industries occur in large, diversified cities because product standardization is not yet in place, and experimentation is the rule. At this explorative stage, information is needed from a range of sources, often from outside the own industry (Gort and Klepper 1982). This implies that local inter-industry spillovers, or Jacobs' externalities, are crucial for young industries. Because firms compete on the basis of the quality of their products and less so on price, high costs in urban environments are less of an issue. By contrast, when products mature and become standardized, firms engage in price competition, and factor costs become more of a concern. This goes along with a shift towards process innovations that require specialized skills and knowledge, which makes industries dependent on intra-industry Marshallian externalities. The dominant location of an industry would therefore move from diversified regions to specialized regions along its life cycle, as different agglomeration externalities are needed in various stages (Henderson et al. 1995; Audretsch and Feldman 1996; Duranton and Puga 2001;

Neffke et al. 2011a)¹. Klepper used a similar ILC framework that, however, challenged this agglomeration thesis² of industry clustering, and proposed a spinoff theory instead³.

In the 1980s and 1990s, many scholars including economic geographers focused on spinoffs as a driving force behind spatial clustering of industries, most notably in Silicon Valley and Route 128 (Dorfman 1983; De Jong 1987; Glasmeier 1988; Mossig 2000). According to Lindholm-Dahlstrand (1997), the first studies on spinoffs even dated back to the late 1960s/early 1970s, and focused exclusively on clusters in high-technology industries in the US⁴. For instance, Dorfman (1983) attributed the high-tech success of Route 128 to agglomeration externalities and the presence of leading universities and research laboratories, but Dorfman also stated that "... the enormous opportunities for new enterprises which the electronics revolution generated and the tendency for such firms to start up mainly as spin-offs from other high tech firms or from university laboratories and to remain close to their sources fueled the tendency towards spatial concentration" (p. 299). Similarly, Kenney and Von Burg (1999) stressed that Silicon Valley owed its success to spinoff dynamics, but also to many other factors like local institutions. These early works on spinoffs and industry clustering did not challenge Marshallian thinking, as the spinoff process was not presented as an alternative mechanism that is sufficient on its own to explain industry clustering.

In the 1990s, scholars described entry dynamics over the life cycle of an industry and applied it to industry clustering. The Organizational Ecology literature (Hannan and Carroll 1992) worked with longitudinal firm-level data and linked the varying entry rates along the industry life cycle depending to firm density levels. In the formative stage of an industry, firm density has a positive effect on entry rates, as each firm may bring forth new entrants. This positive density effect has been referred to as legitimation. However, when the industry grows and matures, higher firm density levels become detrimental for entry due to strong market competition. While the Organizational Ecology framework was originally a-spatial, studies have adopted a geographical perspective in which firm density at the regional level indicates the degree of spatial concentration of firms in an industry. Some of these studies have investigated at which spatial levels the two driving forces of new business formation (i.e. legitimation and competition) are most pronounced (e.g. Hannan et al. 1995; Bigelow et al. 1997; Wenting and Frenken 2011). Empirical studies in particular industries confirmed that

¹ The ILC literature also met critique from economic geographers for depicting the industry life cycle stages as too predetermined, as if industries would automatically evolve from one stage to the next (e.g. Taylor 1986; Chapman 1992). In similar terms, Martin and Sunley (2011) claimed that such a deterministic view would violate evolutionary principles like contingency and open-endedness. Klepper basically agreed with this critique but still found the life cycle concept useful but more as a heuristic device.

² One has to remind that agglomeration economies is an umbrella concept that can mean different things (Hoover, 1948). When Klepper was referring to agglomeration economies, above all, he meant 'localization economies', or 'Marshallian externalities' which are externalities stemming from clustering of firms in the same industry. He also referred now and then to 'urbanization economies' that are available to local firms irrespective of the industry they belong to (Buenstorf and Klepper 2009). Klepper did not account for 'Jacobs' externalities' that come from clustering of many different industries (Jacobs 1969).

³ Klepper had completed a first working paper on this topic already in 2002 which got published only in 2007, after being rejected by economic journals for many years.

⁴ Interestingly, Mayer (2013) points out that Jacobs (1969) already underlined the importance of spinoffs, or 'breakaways', as Jacobs called these, for regional development.

density impacts on entry rates at the regional scale (Baptista and Swann 1999; Sorenson and Audia 2000; Cattani et al., 2003; Stuart and Sorenson 2003; Wezel 2005; Frenken et al. 2015), but no attention was devoted to entry rates of different types of firms, such as spinoffs.

In his book on Path Dependence of 1994, Brian Arthur presented an entry model that simulated the formation of industry clusters as a result of a spinoff process only. In Arthur's spinoff model, each entrant in a new industry is a spinoff of an incumbent firm. Spinoffs locate near the parent company, and they do not relocate to other regions. In the simulation, the probability of a new spinoff in a region is set equal to the share of the region in the total number of firms in the industry. The spinoff model describes a path-dependent process in which small events (the stochastic sequence of spinoffs early on) magnified by positive feedbacks (the more spinoffs in a region, the higher the probability of even more spinoffs) determine the location of the industry. The industry will concentrate in space when some regions, by chance, generate high numbers of spinoffs early on, and, subsequently, produce more spinoffs thereafter. Arthur's spinoff model is still rudimentary though: firms are treated as homogeneous agents, the spinoff process is not depicted as a mechanism through which competences are transferred from parent firms to offspring, so organizational inheritance plays no role, and the firm dynamics are described purely in terms of entry, not in terms of competition and exits (Boschma and Frenken 2003; Dahl et al. 2003).

Sorenson and Audia (2000) and Stuart and Sorenson (2003) combined entry and exit analyses in their studies on industry clustering in the US footwear industry and US biotech respectively. What they found is that local firm density (and thus industry clusters) not only increased entry rates but also exit rates. This finding did not remain unnoticed by Klepper (2007b): "they interpreted this as a reflection of the natural tendency of entry to concentrate near incumbents even in the absence of agglomeration economies ..." (p. 90). This implied that the existence and persistence of clusters is due to incumbents that trigger new entry at the local level, and which compensates for the high exit rates of firms in clusters (Frenken et al. 2015). In other words, these studies fundamentally challenged the foundations of Marshallian thinking that had been based on local externalities that firms could exploit in clusters due to labour pooling, specialized suppliers, and local knowledge spillovers. So, clusters could emerge and persist despite the absence of Marshallian economies.

What Klepper added to this observation of high entry and exit rates in clusters is that there is a need to differentiate between firms that exit and those that survive. Building on the empirical finding that spinoff firms tend to outperform other types of entrants (Shane 2000; Helfat and Lieberman 2002), Klepper made explicit that one needs to differentiate between firms in terms of the competences they possess as soon as they enter the new industry, as this is expected to lead to differential exit rates. In Klepper's theory, the pre-entry background of new entrants was decisive, in particular whether new entrants had inherited (better) capabilities from parent companies in the same industry or not. For Klepper, this insight was crucial to build a theory of industry clustering that was not grounded in high entry rates in clusters *per se*, but in the entry of a particular type of firms, that is, spinoff companies that showed higher survival rates due to inherited competences from their parents. In other words, the spatial clustering of an industry could be attributed to the entry of spinoffs in a region alone, and there is no need for Marshallian economies to make that happen.

Klepper's new theory of industry clustering through spinoffs from incumbent firms was as simple as ground-breaking (Boschma and Frenken 2003; Klepper 2007a, 2010, 2011; Buenstorf and Klepper 2009, 2010; Fornahl et al. 2010). In the formative stage of an industry, a region is lucky to have one or a few very successful entrants. As successful firms generate more spinoffs, and also more successful spinoffs, and as these spinoffs locate in the same region as the parent, a cluster emerges. So, clusters are formed because of a few successful parent firms that pass on their competences to new generations of spinoff firms in the same location. In Klepper's view, the perceived benefits of clustering stemmed directly from firm heritage while clustering in itself did not provide benefits to local firms. Doing so, Klepper challenged standard theory which he somewhat ironically described as the 'not-so-well-founded beliefs' about agglomeration economies (Agarwal and Braguinsky 2014).

It is interesting to see to what literature Klepper refers when he talks about agglomeration economies. This is made explicit in Buenstorf and Klepper (2010) when they explain what forces of industry clustering fall under their Marshallian thesis: (1) natural advantages; (2) localization economies (i.e. Marshallian externalities) and urbanization economies; and (3) pecuniary externalities (New Economic Geography) which make firms locate close to customers and suppliers to save transportation costs. What is not taken up in their account on agglomeration economies are Jacobs' externalities (i.e. benefits that are drawn from a diversified location) (Jacobs 1969), local related externalities (i.e. benefits that are derived from the local presence of related industries) (Porter 2003; Boschma and Wenting 2007), and the whole literature that focuses on regional institutions driving industry clustering (Saxenian 1994; Breschi and Malerba 2001), like Storper's work on untraded interdependencies (Storper 1995) and the industrial district literature (see for an overview, Becattini et al 2009).

In sum, spinoff dynamics and Marshallian externalities are depicted as alternative (though not mutually exclusive) explanations for the location of an industry (Boschma and Frenken 2003; Brenner 2004). Klepper's theory clearly favoured the former explanation. Klepper put his spinoff theory of industry clustering to serious tests by means of systematic descriptive work based on unique longitudinal data on firms and individuals (dubbed as 'nano-economics') and the use of sophisticated quantitative methods (Klepper 2011). Klepper realized more than anybody else that a thorough descriptive qualitative approach and a more testing quantitative approach needed to go together to better understand industry clustering (Braunerhjelm and Carlsson 2011). In this respect, he taught an important lesson that is not always well understood by scholars who have their privileged approaches and operate in self-contained communities. Klepper tested his spinoff thesis by a number of empirical studies, most notably on the US automobile industry that clustered in Detroit (Klepper 2007a; 2010), the US tire industry that concentrated in Akron, Ohio (Buenstorf and Klepper 2009; 2010), and US semiconductors that located in Silicon Valley (Klepper 2010).

In his own studies, Klepper claimed to have found support for his spinoff thesis, because only spinoffs in clusters showed higher entry and lower exit rates. By contrast, he claimed to have found little support for the Marshallian agglomeration thesis, because not all types of firms in clusters had higher probabilities of entry and lower hazards of exit.

Klepper investigated the probability of entry in an emerging industry, most notably in his studies on the US tire industry (Buenstorf and Klepper 2009; 2010), to see whether entrants locate in and are attracted to clusters due to perceived benefits of clusters. Buenstorf and

Klepper found strong evidence for what they called the birth potential in regions which refers to the stock of potential ‘breeders’ of entrants, after Carlton. Their study showed that the probability of entry in the tire industry was higher for spinoffs in regions with many incumbent firms in tires, for diversifiers in regions with many firms in related industries (mainly rubber producers in this case), and for start-ups in regions with high levels of economic activity. With respect to agglomeration economies, they found a modest effect of both urbanization economies and localization economies on the entry probability of start-ups, but not for spinoffs and diversifiers. So, geographical proximity to tire firms increased the likelihood of entry for start-ups, but not for diversifiers. In line with Klepper’s spinoff thesis, geographical proximity to tire firms also increased the entry probability of spinoffs, especially in the Akron region where many spinoffs originated from leading tire firms. However, Klepper did not exclude the possibility that “... spinoff founders also learned from other tire firms in the region ...” (Buenstorf and Klepper 2010, p. 113), which would be consistent with the Marshallian thesis, an issue we come back to in Section 4. The fact that most entrants located in their home region attributed Klepper to high relocation costs and the importance of social networks (Dahl and Sorenson 2012)⁵⁶. Interestingly, what Klepper and Buenstorf (2010) also found is a positive effect of urbanization and localization economies on entrants that did not locate in their home region.

In his studies, Klepper also collected evidence on whether firms in cluster performed better, once controlling for the pre-entry background of the founders. All these empirical studies (Klepper 2007a; 2010; Buenstorf and Klepper 2009; 2010) followed a coherent, step-wise procedure. First, the effect of clustering on survival was assessed by means of a cluster dummy variable (Detroit in automobiles, Akron in tires, Silicon Valley in semiconductors), together with the various pre-entry backgrounds of entrants. In this first step, Klepper always found a positive effect of clusters on survival, suggesting a Marshallian effect. Then, he checked whether spinoffs in the cluster performed better than spinoffs elsewhere. His findings validated this claim, while the cluster dummy variable always turned insignificant, suggesting that the lower exit hazards of cluster firms are confined to cluster spinoffs. Next, Klepper tested whether this superior performance of cluster spinoffs could be attributed to parental heritage or to their cluster location. His findings were always consistent with the former, not the latter, as spinoffs from superior parents showed lower hazards of exit, and the cluster spinoff dummy was no longer significant. Finally, Klepper tested whether this heritage effect was similar for spinoffs located in clusters, as compared to spinoffs outside clusters, as it would demonstrate the absence of a cluster effect. This was taken up by an interaction variable spinoffs from successful parents x cluster. The interaction variable turned out to be insignificant, which led Klepper to conclude that there is no effect of localization economies.

In sum, Klepper found in his own studies that not all types of firms, but only spinoff firms showed a higher performance in clusters. This made Klepper conclude that his spinoff thesis

⁵ This latter finding has been replicated by Carias and Klepper (2010) in their study on Portuguese entrants and Buenstorf and Geissler (2011) in the German laser industry.

⁶ Interestingly, Buenstorf and Guenther (2011) found that firms in the machine tool industry that relocated from East to West Germany after the Second World War were still capable of exploiting their firm-internal capabilities they had acquired before the relocation (and therefore performed better than new entrants without pre-war industry experience, for instance), while they did not perform better because of agglomeration economies in their new host locations.

explained industry clustering. Having said this, even Klepper did not rule out that agglomeration economies might still be at work, as cluster spinoffs might possess the right capabilities to benefit fully from clusters, due to their pre-entry background (Klepper 2007). This will be taken up further in Section 4.

Other researchers soon followed in Klepper's footsteps. Longitudinal studies that applied a similar, though not identical framework found support of Klepper's thesis on spinoffs, like studies on the UK car industry (Boschma and Wenting 2007) the global fashion industry (Wenting 2008), the Dutch publishing industry (Heebels and Boschma 2011) and the US semiconductor industry (Kowalski and Veloso 2015). These studies confirmed that clusters do not increase survival, and industry clustering is primarily the result of a local spinoff process. Some studies (e.g. Boschma and Wenting 2007) found even a negative effect of localization economies on survival, particularly at a later stage in the industry life cycle. However, not all studies have come to the same conclusions, and there are some remaining challenges for empirical research in the context of Klepper's work on industry clustering that will be discussed further in Section 4. Before we take that on, we discuss first how his ideas and findings have diffused in economic geography.

3. Influence of Klepper's work on economic geography

So far, we described how new Klepper's theory of industry clustering was to the field of economic geography, but did it make any impact in economic geography? We already discussed empirical studies that soon followed Klepper's work on industry clustering. This section presents a citation analysis to Klepper's work in economic geography journals. Moreover, we describe how his ideas have been applied further in the economic geography field which includes urban economics, regional economics and 'economic geography proper'.

To measure the impact of Klepper's work, we calculated the number of forward citations (the publications that cite his publications) on 12 July 2014. Klepper published a total of 56 articles in scientific journals and 1 book chapter between 1980 and 2013. We used Scopus where 48 of his 56 publications can be found. Most of Klepper's articles that are missing in Scopus have been published in the early 1980s. His bibliography on Scopus is complete from 1992 onwards. We analyze Klepper's forward citations from 1996, the first year of forward citations available on Scopus, until 2013. We take into account only peer-reviewed publications in scientific journals and editorials in scientific journals that cite Klepper. Thus, we excluded book chapters, working papers, and so on. Also, we excluded self-citations.

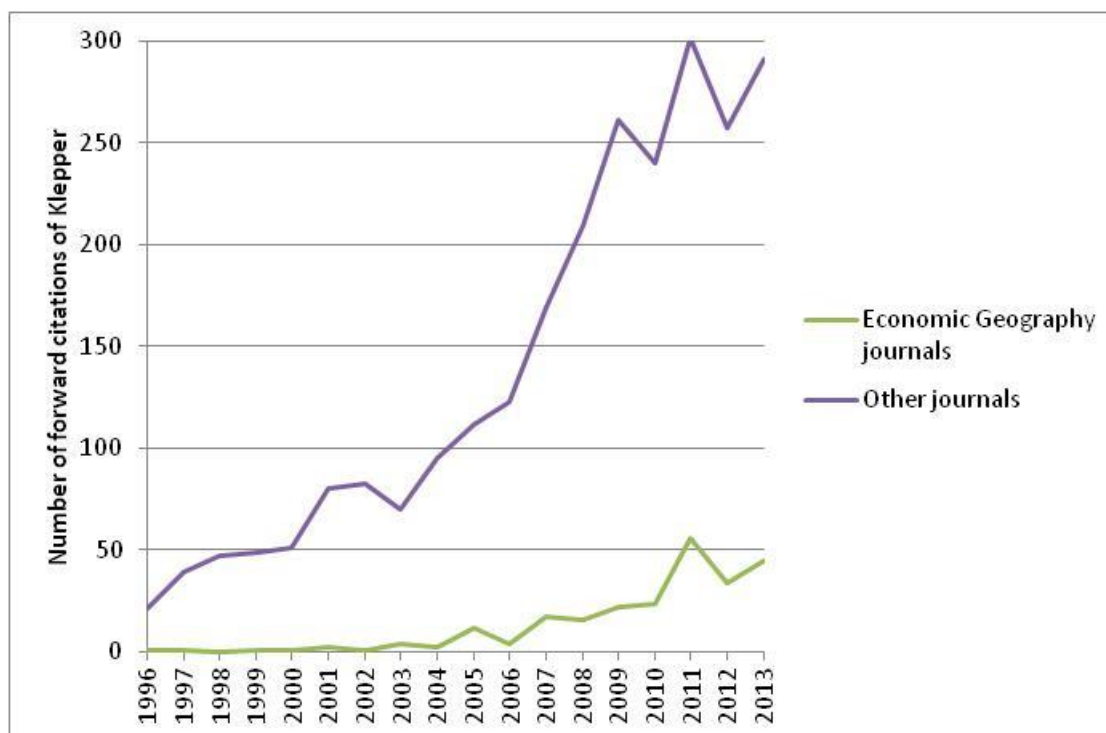
Klepper has been cited in 1,843 publications in 554 different journals between 1996 and 2013. In these publications, Klepper has been cited 2,741 times. We made a distinction between forward citations in economic geography journals and other journals. Of the 554 journals in which Klepper has been cited, we classified 29 journals as belonging to the field of economic geography (see Table 1). Of the 1,843 publications that cite Klepper, 146 come from economic geography journals with a total of 243 citations. Figure 1 shows that, since 2005, there is a slow but gradual increase in the number of forward citations to Klepper's work in economic geography journals, with a peak in the year 2011. Moreover, Klepper published 7

articles on geography since 2006, which received a total of 147 forward citations (71 citations in economic geography journals, 76 citations in non-economic geography journals).

Table 1: Economic Geography journals that contain publications that cite Klepper

Acta Geographica Sinica	Journal of Economic Geography
Annals of Regional Science	Journal of Regional Science
Applied Geography	Journal of Urban Economics
Cambridge Journal of Regions, Economy and Society	Norsk Geografisk Tidsskrift
Economic Geography	Papers in Regional Science
Entrepreneurship and Regional Development	Professional Geographer
Environment and Planning A	Regional Science and Urban Economics
Environment and Planning B: Planning and Design	Regional Studies
Erdkunde	Review of Urban and Regional Development Studies
European Planning Studies	Rivista Geografica Italiana
European Urban and Regional Studies	Tijdschrift voor Economische en Sociale Geografie
GeoJournal	Tourism Geographies
Geographische Zeitschrift	Urban Studies
Investigaciones Regionales	Zeitschrift fur Wirtschaftsgeographie
Jahrbuch fur Regionalwissenschaft	

Figure 1. Number of forward citations of Klepper 1996-2013



It would go too far to say that Klepper's work on spinoffs has been very influential in the field of economic geography. What comes more close to the truth is that his ideas slowly entered the field and met relatively little opposition. Scholars citing Klepper's work have been positive almost without exception. It is hard to assess whether this lack of critique reflects a general consent with Klepper's work, or that it reflects the rather fragmented state-of-affairs in the economic geography discipline, with no real debates between the scattered segments. For sure, the work of Klepper has become a main pillar in an expanding strand of literature in economic geography, that is Evolutionary Economic Geography (EEG), which depicts the spatial evolution of the uneven distribution of economic activity as the outcome of contingent, path dependent processes (Boschma and Frenken 2006; Martin and Sunley 2006). The spatial clustering of an industry is a topic in particular that can be analyzed from an evolutionary perspective in terms of the locations of entries, spinoffs and exits driving the spatial distribution of firm-specific routines over time (Boschma and Frenken 2003). This has been confirmed by Golman and Klepper (2013) who stated that "the model of the spinoff formation and clustering fits naturally into a framework for evolutionary economic geography ..." (p. 27). Surely, it has been one of the most successful applications in EEG so far, and Klepper's work on industry clustering has been the main source of inspiration.

A recent spinoff of Klepper's work is the growing literature in economic geography on regional branching (Frenken and Boschma 2007; Boschma and Frenken 2011), which argues that the formation of new industries is strongly rooted in local capabilities drawn from related industries. Klepper (2002) attached great importance to diversifying firms from related industries in the formative stage of an industry, which were expected (like spinoff companies) to outperform other types of entrants, and for which he found strong empirical support (e.g. Klepper and Simons 2000; Klepper 2006). This made him believe that regions with industries that are related to a new industry (and with a higher fraction of high competence firms in these related industries) have a higher probability to enter that new industry. This was confirmed in a number of his empirical studies (Klepper 2007c). For instance, Buenstorf and Klepper (2009; 2010) tested in their study on the US tire industry whether the entry probability was positively affected by the presence of related industries (i.e. rubber manufacturers) in a region: for diversifiers it did matter, but not for spinoffs and start-ups⁷. However, Klepper did not test whether the local presence of related industries had a positive impact on firm performance. Boschma and Wenting (2007) showed that some regions were better candidates than other regions in Britain to host the new car industry because of the local presence of related industries, from which many successful entrants in British car making spawned. Their study demonstrated that being located in a region with related industries like cycle making, besides being an entrant with previous experience in related industries, increased firm survival during the formative stage of the British car industry.

More systematic evidence on this process of spatial branching has been provided recently. Hidalgo et al. (2007) demonstrated that the existing set of capabilities in a country determines which new export products are feasible to develop. Countries tend to move into new products

⁷ Buenstorf et al (2015) concluded that a local supply of related activities (i.e. laser source producers) impacted on the spatial emergence of the laser systems industry in West Germany, because of local laser source producers diversifying into laser systems, instead of acting as a local source of knowledge spillovers.

that are related to their current export products, and richer countries with many related export products have more opportunities to diversify into new products. Neffke et al (2011b) was the first paper that found systematic evidence for such branching at the regional scale. Analyzing the entry of many new industries in 70 Swedish regions in the period 1969-2002, they demonstrated that a new industry had a higher probability to enter a region the higher the number of local industries to which the new industry was technologically related. Other studies have come to similar conclusions, like studies on the industry evolution in Spanish regions (Boschma et al. 2013), industry evolution in 360 US metropolitan areas 1977-1997 (Essletzbichler 2015), the evolution of patent knowledge bases in US metropolitan areas 1975-2005 (Rigby 2013), the entry of new technological knowledge in 366 US cities 1981-2010 (Boschma et al. 2015), and the emergence of the fuel cell industry in European regions 1993-2007 (Tanner 2014). This systematic evidence underlines the importance of region-specific, localized capabilities as sources of diversification (Bathelt et al. 2013).

In sum, broadly speaking, Klepper's work has had an impact on the field of economic geography, and it is growing. However, there are issues that are currently discussed which are still open or in need of more evidence in the context of Klepper's spinoff theory on industry clustering. These will be taken up and discussed further in the next session.

4. Some unresolved issues

For Klepper, the ultimate test for his spinoff thesis of industry clustering was whether "all the perceived benefits of clustering are in fact benefits that stem from firm heritage (the quality of the parent)" (Agarwal and Braguinsky 2014, p. 22). As outlined above, Klepper and others have been successful in providing evidence for his heritage theory. The question remains though to what extent this evidence is also consistent with Marshallian thinking, as the Marshallian view is not necessarily incompatible with the heritage thesis. Klepper was the first to admit that agglomeration externalities cannot be ruled out entirely in his own studies. He mentioned two observations in particular. First, Klepper (2011, p. 149) argued that the disproportionately higher share of spinoff entries in clusters (in US automobiles, almost half of all entrants located in Detroit versus 15% elsewhere, and in US semiconductors, 93% of all entrants located in Silicon Valley versus 39% elsewhere) cannot be explained by the spinoff process alone, and that location factors such as non-compete covenants at the US state level might have played a role. Second, Klepper left open the possibility that spinoffs in clusters outperform other firms because their superior capabilities make them more fit to benefit from Marshallian externalities (Klepper 2007a, 2010; Buenstorf and Klepper 2010).

As discussed in Section 2, longitudinal studies on firm survival in the UK car industry (Boschma and Wenting 2007) and the Dutch publishing industry (Heebels and Boschma 2011), among others, found support for the spinoff thesis, and no or even a negative effect of Marshallian externalities. Other sector studies found a positive effect of localization economies on survival instead, as in the case of the Portuguese plastic injection moulds industry (Costa and Baptista 2011; 2015) and the global video game industry (De Vaan et al., 2013). This suggests the importance of industry specificity (Nystrom 2007). De Vaan et al. (2013) argued that most studies, including Klepper's own studies, have looked almost exclusively at manufacturing sectors, while the clustering process in creative, project-based

industries is more likely to be driven by positive localization externalities, because they rely more on local buzz and social networks that function as local repositories of knowledge (Grabher 2004). Consequently, the extent to which firms in these industries have access to such social networks will affect their ability to survive. Similarly, Wenting and Frenken (2011) attributed the spatial clustering of the fashion industry to the rapid turnover of ideas in fashion design. Also Klepper (2011) himself suggested that industry specificity might play a role, as not all industries exhibit extreme spatial clustering, and the spinoff process might be less prominent in some industries. In an unpublished paper, Klepper (2007c) attributed the more dispersed spatial pattern of the US television industry to the dominance of diversifiers from leading radio producers which left little room for spinoffs, which stood in contrast to the case of the US car industry that showed a more clustered spatial pattern because spinoffs from leading car producers made the difference. Buenstorf and Geissler (2011) found that the German laser industry was less concentrated geographically because public research, which is geographically dispersed in Germany, acted as a local source of academic entrepreneurship and enhanced other types of entry in lasers, suggesting an agglomeration effect. For sure, this issue of industry specificity needs to be taken up in future research.

There is another way in which agglomeration externalities might matter, and that is through local related externalities (Porter 2003; Boschma and Wenting 2007; Eckstein 2014). Studies have demonstrated that the local presence of related industries increases entrepreneurial activity (Delgado et al. 2010) and the survival of plants in manufacturing (Neffke et al. 2012). As discussed before, Klepper did not test in his studies whether the presence of local related industries, besides local intra-industry externalities, affected firm survival in a new industry. There is increasing evidence though that industry clustering is favoured by local related externalities, especially during the formative stage of an industry. Boschma and Wenting (2007) found lower failure rates of firms in regions with high levels of employment in technologically related industries, and higher failure rates in high concentrations of firms within the same industry. There are good reasons to expect that such a combination of positive related externalities and negative localization externalities occurs. Local related externalities may arise from knowledge spillovers and labour mobility between non-competing firms across related industries, while negative localization externalities may stem from local competition and unintended knowledge spillovers between competing firms within the same industry (Frenken et al. 2015). This also underlines how misleading it can be to take a broad definition of localization economies that does not disentangle analytically local intra-industry externalities from local related-industry externalities, as both types of externalities may have opposite effects on firm survival (Staber 2001; Neffke et al. 2012).

According to Klepper, the Marshallian thesis could be rejected when there are neither higher entry probabilities nor lower hazards of exit for all types of firms in clusters. However, one should be cautious to conclude that localization economies are absent just because not all cluster firms benefit from co-location. Indeed, from an evolutionary perspective, it perfectly makes sense that not all local firms benefit from clustering, as firms are heterogeneous in their capabilities. This is also what Giuliani (2007) stressed in her studies on knowledge networks in clusters, in which she demonstrated that knowledge is not ‘in the air’ in clusters, as Marshall once put it, but circulates in local networks to which only the cluster firms with the best capabilities have access. This implies that firms are likely to differ in their ability to benefit from and exploit localization economies (Rigby and Brown 2013). So, while there

may be no effect of localization economies for the whole sample of firms, if one differentiates between different types of firms, the effect of localization economies might still show up. This is exactly what Klepper (2007a) suggested when discussing the superior performance of spinoffs in clusters: “it is possible that agglomeration economies in the Detroit area were significant but only benefitted spinoffs, perhaps because only they had suitable pre-entry backgrounds to benefit from agglomeration economies. It is hard to rule out such a theory ...” (p. 629) (see also Cusmano et al. 2015). So, capabilities of firms may be decisive for whether firms are able to reap the benefits and bear the costs of spatial clustering. This needs to be incorporated more explicitly in future research.

Klepper (2011) was the first to recognize that follow-up studies were needed to exclude more precisely the possibility of Marshallian externalities. For this purpose, he started up a number of new studies, most notably Carias and Klepper (2010) and Cheyre, Klepper and Veloso (2014) that focused on the role of labour recruitment for entry and survival of firms. Both papers were set up as a further test for his spinoff thesis, but now through local flows of employees, instead of entrepreneurs, between parents and offspring. In their study of inventors’ mobility in US semiconductors, Cheyre et al. (2014) found that labour mobility had an impact on the clustering of the industry in Silicon Valley through the spinoff process: spinoff entry raised local labour mobility, as spinoffs locate close to their parents to be able to recruit well-known employees from their parents. The big question here is how to interpret this finding in light of agglomeration theory that would claim that clustering leads to higher labour mobility, increases labour matching both for workers and firms, and enhances knowledge diffusion across local firms (Duranton and Puga 2004). Cheyre et al. (2014) suggest that if labour mobility gives rise to local knowledge diffusion, it will benefit mainly new entrants (like spinoffs), and not all firms in a cluster, and thus may not constitute an agglomeration economy. But as the same scholars admit themselves, this remains a challenging question: while their findings seem to suggest that new entrants such as spinoffs in clusters benefit from local labour pooling but not their parents and other local incumbents, they cannot exclude either the possibility that these incumbents might still benefit from local labour pooling through other mechanisms, like clusters may attract a large and diverse pool of labour from outside the region, generate a local supply of graduates, or provide other knowledge spillovers.

Carias and Klepper (2010) employed a matched employer-employee dataset to investigate whether entry but also survival of new firms could be associated with labour recruitments in their first years of existence. What they found is that “... knowledge about potential hires, particularly old colleagues, provides a strong incentive to locate close to home, especially for firms that enter in their home industry” (p. 29). Besides an effect on entry, they also found an effect on survival: firms that entered in the same region and same industry had higher survival rates when hiring former colleagues and workers from the same industry and the same region. These findings of Carias and Klepper (2010) led Agarwal and Braguinsky (2014) to conclude that “... pooling of labour resources may ... be caused not so much by general external effects available to all firms in clusters, but by a targeted mechanism through which founders of new firms hire their former colleagues for the superior knowledge they possess” (p. 23).

Still, local labour market economies cannot be ruled out either, as Cheyre et al. (2014) acknowledged. This becomes apparent when taking a deeper look at the two types of labour

mobility Carias and Klepper (2010) distinguish. The first type concerns former colleagues of the founder that are hired by the new firm. Here, entry of new firms and their higher survival in clusters can be attributed almost exclusively to their link with their parent, and not to clustering *per se*, which accords to the spinoff thesis. However, the second type is more difficult to interpret. It concerns employees that are hired by the new firm from other local firms in the same industry because the founder interacted with these employees when still working for the parent and so learned about the superior skills of these employees. On the one hand, one could argue that the spinoff hypothesis holds because recruitments are done through a previous (though indirect) link with the parent. But on the other hand, one cannot rule out a thick labour market effect either, because new spinoff firms have more of such recruitment options from nearby firms as interaction opportunities of their parents are larger in clusters, and because the hired employees may have learned and benefitted from local knowledge spillovers in the past.

Another possible type of Marshallian externalities is based on input-output relationships, especially the local presence of suppliers of specialized knowledge. This has received little attention in Klepper's work. There are three options to link more closely the role of supplier relationships to his spinoff thesis: (1) spinoffs locate close to their parents to be able to establish economic and knowledge relationships with their parents, and spinoffs also perform better because of this relationship; (2) key suppliers can also be local spinoffs from the principal industry, as was the case with important machinery firms in the Akron cluster that supplied to the local tire and rubber industry⁸; (3) spinoffs depend on relationships with other local firms because the founder interacted with these specialized firms when still working for the parent, and so learned about their superior capabilities. This latter option has been suggested by Buenstorf and Klepper (2009): "it could be that spinoffs learned from their parents about where to secure their specialised intermediate inputs. If superior firms had superior suppliers, this might help to explain the distinctive performance of their spinoffs" (p. 731). It should be reminded though that in this third option, the effect of Marshallian externalities cannot be excluded either, because these local superior suppliers may have benefitted from their location in a cluster, and have become smarter as a consequence. The first option may be more rare though, as spinoffs may have little economic relationships with their parents besides labour recruits (Buenstorf and Klepper 2009; Mayer 2013). So, there is a need for studies to assess whether spinoffs are part of local knowledge and input-output networks in clusters, what the impact of their network positions in clusters has been on survival, and whether a strong local linkage between parent and spinoff mattered in particular.

Institutions also received little attention in Klepper's empirical work on industrial clustering, although the role of local institutions has been a hallmark of Marshallian thinking, like in the literature on Marshallian industrial districts (Becattini et al. 2009). For Klepper (2010), the success of Silicon Valley could solely be attributed to a successful local spinoff process, while for scholars like Saxenian (1994), for instance, it was due to a more open and decentralized industrial system that promoted collective learning and innovation in Silicon Valley, in contrast to Route 128. Klepper tended to challenge such an institutional approach, but he also admitted that it could be interesting to look at regional institutions, as it might influence entry

⁸ I am grateful to Guido Buenstorf for mentioning this option.

activity of spinoffs in regions in particular. In this respect, Klepper (2010) suggested to investigate the effect of US state laws of employee non-competes on spinoff activity, as it might explain why Silicon Valley, which had no such institutional restrictions on labour mobility at the state level, and not other US states had such a high spinoff activity in semiconductors⁹. Wenting and Frenken (2011) investigated entry levels across cities in the fashion industry, and found that institutions like cultural resistance against ‘commercialization’ and ‘popularization’ of fashion design, prevented the successful development of ready-to-wear in Paris after the Second World War, despite a strong local presence of a haute couture cluster. Menzel and Kammer (2012) made a first attempt to integrate more fully institutions in Klepper’s spinoff framework, and attributed notable differences between the US and Denmark in their entry and survival patterns in the wind turbine industry to their different institutional systems (see also Eckstein 2014). Last but not least, accounting for possible effects of institutions on industry clustering would also connect the Klepperian literature more tightly to evolutionary approaches that focus on the importance of new institution-building that co-evolves with new industry formation (Nelson 1994).

5. Conclusion

The paper has outlined how Klepper’s spinoff theory on industry clustering deviated from Marshallian thinking. We explored how ‘new’ Klepper’s spinoff theory was by looking at relevant literatures that predated his own work, to assess his own contributions to the industry clustering literature. Back in the 1980s, and even before that, scholars linked spinoff activity to the emergence of high-tech clusters. In the 1990s, scholars employed entry models in an ILC framework to show that entry rates can drive the spatial concentration of an industry. In the early 2000s, Sorenson and colleagues combined entry and exit analysis, and found that industry clustering not only increased firm entry but also firm exit rates. This implied that clusters could emerge and exist because they provide entry opportunities but they do not necessarily generate Marshallian economies that increase firm survival. Arthur described industry clustering as a self-reinforcing process of local spinoff entry, but he ignored the role of heterogeneous firms, organizational inheritance, and competition between firms. Following studies on spinoffs, Klepper introduced firm heterogeneity to this literature, in terms of the capabilities firms possess when they enter a new industry, as this leads to differential exit rates. For Klepper, industry clustering was not due to high entry rates in clusters *per se*, but due to the local entry of spinoffs that showed lower exit rates in clusters due to superior competences they inherit from successful parents. In that way, there was no need for Marshallian economies to make industry cluster geographically.

The paper also assessed the impact of Klepper’s new theory on the field of economic geography. A citation analysis of Klepper’s work in economic geography journals showed that his influence is growing. For sure, his work has been highly influential in one particular branch of economic geography, that is Evolutionary Economic Geography. His empirical studies on industry clustering triggered many follow-up studies. More recently, Klepper’s

⁹ Moreover, some regions are characterized by entrepreneurial cultures, as embodied in persistent high entry rates over long periods of time (Andersson and Koster 2011; Fritsch and Wyrwich 2014). This may be regarded as an institutional quality of regions that drives entry rates in general, and spinoff formation in particular.

work has inspired a rapidly expanding literature on regional branching which claims that regional diversification is strongly rooted in local capabilities, out of which new industries grow that recombine capabilities from local related industries.

The final part of the paper identified issues on industry location that are still left open, unanswered or in need of more evidence in the context of Klepper's theory. In his own studies, Klepper confirmed the validity of his spinoff thesis, and found little evidence for the Marshallian thesis. Having said that, Klepper recognized that agglomeration economies cannot be ruled out completely in his own studies. Industry specificity might play a role. Manufacturing industries might be different from creative, project-based industries which rely more on local buzz and local social networks. Moreover, local related-industry externalities matter in the spatial formation of industries, especially in their emergent stage. It appears to be crucial to distinguish between local intra-industry externalities and local related-industry externalities, as these two types may have opposite effects on firm performance. This has been confirmed by studies on firm survival that found positive local related externalities and negative localization externalities. There is also a need to be more precise on the question which firms have more capabilities to reap the benefits and bear the costs of spatial clustering. Preferably, this should be investigated for the three types of Marshallian externalities (labour market, knowledge spillovers and network relationships) and the role of institutions separately, as each of them may have a distinct effect on entry and exit levels. Needless to say, this puts high demands on the quality of longitudinal micro-data along the life cycle of industries. This is not, however, a mission impossible for many industries, as the availability of longitudinal micro-data on local labour markets (by means of matched firm-employee data) and local knowledge spillovers (by means of research collaborations, patent citations, co-publications, etc.) is quite good in many countries. However, data availability on local institutions, and even more so on local input-output relationships, is much more restricted.

For sure, all these challenges call for identification strategies that need to make a sharp distinction between the spinoff thesis and the Marshallian thesis. Klepper was absolutely a master in this respect, and there is no question he would have played a leading and pioneering role in this new research agenda. Only for this reason already, we miss him deeply.

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