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The Dynamics and Evolution of Local Industries – The case of Linköping

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ABSTRACT

This paper aims to analyse how innovative, individual activities influence the evolution of local industries according to three stages. When discussing the evolution of industries or economies, the concept of path dependency is often a central element. Its vague nature makes it however difficult to be used as an interpretative lens when studying the evolution of local industries. In order to limit the broad concept, several aspects have been identified for discussion; all are explicitly linked to path dependency in economic geography literature and all are acknowledged to be of significance for stimulating the evolution of local industries. Based on the review of the evolutionary economic theory literature, the following three stages have been identified: first, the entering of new knowledge which may, or may not, be the starting point for a new local industry; second, the formation of the new local industry; third, the anchoring process of the new local industry. All three stages are intertwined and include the question how the new emerging industry and the existing local structures relate to each other. The three stages will be illustrated through the discussion of the evolution of the IT industry in Linköping, Sweden.

Keywords: Entrepreneurship, local economic development, institutional foundation, informal institutions, path dependency

JEL codes: R11, N94, O14

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Abstract- This paper aims to analyse how innovative, individual activities influence the evolution of local industries according to three stages. When discussing the evolution of industries or economies, the concept of path dependency is often a central element. Its vague nature makes it however difficult to be used as an interpretative lens when studying the evolution of local industries. In order to limit the broad concept, several aspects have been identified for discussion; all are explicitly linked to path dependency in economic geography literature and all are acknowledged to be of significance for stimulating the evolution of local industries. Based on the review of the evolutionary economic theory literature, the following three stages have been identified: first, the entering of new knowledge which may, or may not, be the starting point for a new local industry; second, the formation of the new local industry; third, the anchoring process of the new local industry. All three stages are intertwined and include the question how the new emerging industry and the existing local structures relate to each other. The three stages will be illustrated through the discussion of the evolution of the IT industry in Linköping, Sweden.

INTRODUCTION

The emergence of new industries, the decline of others and changes in their overall importance over time constitute an important driver of modern economic growth (Malerba & Orsenigo, 1996; Schumpeter, 1939; Kuznet, 1930). Despite that, it is widely acknowledged that this is a continuous evolutionary process, Malerba and Orsenigo (1996) criticize the fact

that theoretical models primarily have focused on static analysis of the economic structure in the past. Only in recent years has empirical research started to address the evolution of industrial and local economic structure (Martin & Sunley, 2007; Boschma & Lambooy, 1999).

Much research has been done on why some locations are more successful in transforming and renewing their economic structure than others (e.g. Hassink, 2005; Grabher, 1993). One important finding in the literature was that newly emerging industries did not necessarily form in economically strong regions, but often stimulated the growth and development of rather unknown places, such as Akron in the US (Buenstorf & Klepper, 2009), Silicon Valley in the US (Saxenian, 1996) and Bavaria in Germany (Neffke et al., 2009). Taking Germany as an example, the Ruhr area was once a thriving economic centre, but its importance has diminished, while formerly rather unknown places such as Bavaria and Baden-Württemberg have evolved into economic success stories.

Changes in industrial and local economic structure are often understood from the perspective of evolutionary economic theory. Within this theoretical approach, Martin and Simmie (2008) distinguish three overall perspectives. First, generalised Darwinism applies concepts such as variation, novelty, selection and continuity to explain the evolution of firms and industries (e.g. Essletzbichler & Rigby, 2010; Laurent & Nightingale, 2001; Aldrich & Fiol, 1994). Second, the theory of complex adaptive systems draws on complexity theory and aims to understand how networked forms of economic activity are developing and how behaviour on the micro level shapes behaviour on the macro level (e.g. Martin & Sunley, 2007; Frenken & Nuvolari, 2004; Krugman 1996). Third, path dependency theory emphasizes the importance of past decisions for present decisions. By this means, path dependency theory explains distinct, long-term patterns of technological and industrial development and gives a special consideration to ‘historical accidents’.(e.g. Belussi & Sedita, 2009; Shapira & Youtie, 2008; Schienstock, 2007; Hassink, 2005; Essletzbichler & Winther 1999).

These three perspectives are closely related, but in this analysis of the evolution of local industries, I will primarily use the theory of path dependency. Much research is done on the spatial and temporal persistence of trajectories, while the historical accidents which alter the given trajectory are exogenous to the economic models and analysis (Andersson & Koster, 2011; Buensdorf & Klepper, 2009; Klepper, 2007). In contrast to the other two perspectives, the theory of path dependency stresses the importance of 'historical accidents' for the emergence and evolution of industries. Furthermore, the path dependency theory has been recently extended beyond the evolution of firms and industries to the analysis of regional evolution. Martin and Sunley (2006: 402) define path dependency as a *'probabilistic and contingent process [in which] […] the suite of possible future evolutionary trajectories (paths) of a technology, institution, region, firm or industry is conditioned by (contingent on) both the past and the current states of the system in question, and some of these possible paths are more likely or probably than others.*' In this paper I address two shortcomings in contemporary literature and research that have addressed the issue of path dependency in relation to change and renewal in local economies. First, it is acknowledged that the concept of path dependency often is used in a very general sense and the question about its applicability as a framework in studies of local economies remains largely unresolved. In this vein, Martin and Sunley (2006: 402) object that the unresolved issues associated with path dependency need further elaboration before the concept can be adopted as an explanatory framework for regional development scholars. As such, I provide in this article a review of previous studies that have used the concept in order to discuss and develop its applicability in studies of local economic development. Second, in line with recent calls (e.g. Klepper, 2010; Boschma & Iammarino, 2009) the need for a more actor-centred view on local economic evolution is acknowledged where individuals rather than processes or networks are the starting point of regional and local economic development. Hence, while the focus is on the process of evolution I specifically include individuals and their driving forces in the analysis.

This paper aims to analyse how innovative, individual activities influence the evolution of local industries according to three stages. The three stages will be illustrated through the discussion of the evolution of the local IT industry in Linköping, Sweden. Of special focus will be the impact of 'historical accidents' in changing the local circumstances. In that sense, the focus is not on the evolution of the local IT industry per se, but rather on how historical accidents changed the local circumstances and enabled the emergence of the IT industry through innovative, individual activities. Linköping is one example of a formerly unknown place which developed into a Swedish economic success story (Hommen et al., 2006; Klofsten et al., 1999). As 'historical accidents' are case specific and are by definition unpredictable, a case study is the suitable approach for understanding the alteration of local trajectories. The concept of path dependency will be used as an interpretative lens.

The rest of this paper is structured as follows. In the following section, the theoretical framework is developed and will provide an overview of the concept of path dependency; namely, how it has been used and its shortcomings will be presented. In the next section, three stages of the evolutionary industry development process in a local economy have been identified. This will make it possible to tie the study about local industry evolution and path dependency to a few concrete stages. The case study will then be analysed according to these three stages. The last section draws conclusions.

THEORETICAL FRAMEWORK

Evolutionary economic theory provides a rich set of possible explanations for changes in local economies. According to Dosi and Nelson (1994), evolutionary theory needs to have the following characteristics. On the one hand, evolutionary theory aims to explain the movement of something over time. On the other hand, the explanation should include both random elements which alter variables in question and mechanisms that systematically winnow on extant variation (selection). In a later article, Nelson (1995) identifies a third characteristic

involving a certain continuity of the winnowing. As the next section will show, the concept of path dependency is based on these three criteria.

Path dependency: The importance of history

Largely embedded in evolutionary economic theory, the concept of path dependency stresses the importance of history for current activities. However, the applicability of the concept seems somewhat problematic as no clear definition can be found in literature (Martin & Sunley, 2006). The concept is discussed in many different contexts and its importance has been recognized in many disciplines (cf. Martin & Sunley, 2006 for an in-depth analysis). Unfortunately, this variety of contexts and disciplines seems to have hindered the development of a concrete definition. Mostly, path dependency is defined as small historical accidents which influence present decisions. Therefore, before moving on to the analysis, it has to be critically discussed first whether and to what extent this concept is suitable to be used as an interpretative lens.

Within social science, the works of Arthur (1989, 1994), David (1985) and North (1990) are the most prominent references. The concept was initially introduced in economics to explain technological adaptation processes and industry evolution (Arthur, 1989; David, 1985). The main arguments for path-dependent processes were three features: quasi-irreversibility of investments, economies of scale and technical interrelatedness. In other words, through historical accidents, sub-optimal technologies will remain dominant precisely because of these three features even if a more superior technology will emerge later on (David, 1985). Due to increasing inflexibility, the industry becomes more and more locked in to a certain technology (Arthur, 1989).

Lately, path dependency has also been discussed on a regional and local level (Shapira & Youtie, 2008; Hassink, 2005; Meyer-Stam, 1998). In this paper, I analyse the dynamics and evolution of a local industry, but of special focus are the impact of ‘historical accidents’ on the changing local circumstances which enabled the emergence of the local IT industry

through innovative, individual activities. In that sense, this study has a combined local and industry perspective. Historical accidents are somewhat random happenings and it can be assumed that it is not only important that these accidents are happening, but also when. In that sense, it is not only the activity itself which is important, but its importance depends also on its timing. If the particular activity would have been taken earlier or later, the impact would have been rather different.

Some basic mechanisms of technological path dependency can also be observed on the regional and local level: quasi-irreversibility of investments, economies of scale as well as technical interrelatedness hold true also on the regional level. Nonetheless, path dependency on the regional and local level increases the level of complexity for several reasons. First, the path of a single industry focuses on similar activities of firms. A geographical approach, however, brings in the environment of the location and a broader range of organisations into the analysis. Second, regions and cities usually do not house only one single industry, but several. It is therefore much more difficult to identify the path of a geographical area. It can however be assumed that due to learning processes, knowledge accumulation within the location will lead to a path-dependent specialization of this location. Among other factors, a new technology can make such a specialization obsolete. The region faces the challenge to be locked in to a technological setting which is diminishing over time. It is precisely this discussion about why some regions are able to reinvent themselves while others fail which is the main question of many evolutionary papers with a regional focus. Andersson and Koster (2011: 181) define path dependency as a *'process in which later conditions are dependent on previous ones, such that development trajectories depend on initial conditions'*. Belussi and Sedita (2009:507) suggest that *'path dependency might lead to lock-in phenomena, where fixity and rigidification are the characteristics of local economic development'*. Martin and Sunley (2006:399) describe path dependency as the *'inability to shake free of the own history*'. David (2001:15) states that *'the concept of path dependence refers to a property of*

contingent, non-reversible dynamical processes, including a wide array of biological and social processes that can properly be described as evolutionary'. According to Essletzbichler and Winther (1999: 179) path dependency means that *'the dependence of technology on past and existing knowledge tends to move firms, regions and countries along relatively well-defined technological trajectories'*.

There is no clear definition of path dependency in the literature, but it is vaguely defined as the importance of historical events for future decisions. Path dependency is used in different contexts and how it is specified depends very much on the context. Conclusively, it is often not perfectly clear what the actual path is, why some historical events are more important than others, and to what extent they can influence present and future decisions. These important events are context-based, which means that they are different in different locations and in different times. Only in retrospect can the researcher identify the historical events and estimate their importance. It should be noted that beside these rather vague descriptions, no further conceptualisation is offered in most of the literature. Often path dependency is mentioned in the title as a catch-phrase, but is not further addressed in the paper (e.g. Shapira & Youtie, 2008). This fuzziness makes it difficult to use the concept as an analytical framework. It has however been proven to be difficult to find a more concrete definition of path dependency in a regional, local or industry context. Martin and Sunley (2006) provide a comprehensive summary of unresolved issues associated with path dependency and of unanswered key questions associated with regional path dependency. Following Martin and Sunley's (2006) critique, I chose an alternative approach which breaks down the broad concept of path dependency to three evolutionary stages of local industries discussing both the individual activities of different local actors and non-local activities with a local impact according to these three stages.

Three stages of evolution of local industries

Much research has been done on lifecycles of products (e.g. Murmann & Frenken, 2006; Klepper, 1996; Vernon, 1966; Levitt, 1965), clusters (e.g. Martin & Sunley, 2011; Menzel & Fornahl, 2010; Van Klink & De Langen, 2001) and industries (e.g. Agarwal, et al., 2002; Audretsch & Feldman, 1996a; Covin & Slevin, 1990). Two research streams suggest that also regions might develop along different phases analogous to the lifecycle. First, the recent interest in explaining the development of local economies with an evolutionary approach (Martin & Sunley, 2007; Boschma & Lambooy, 1999) implies different stages. Second, also the research efforts on explaining why some locations are more successful in transforming and renewing their economic structure than others (e.g. Hassink, 2005; Grabher, 1993) propose different development stages of a region. Audretsch et al. (2008) found empirical evidence that regions evolve over a well-defined lifecycle. Nonetheless, research on regional lifecycles has been scarce so far. After reviewing the relevant evolutionary literature, the papers could be grouped according to three aspects which can be understood as three stages of evolution of a local industry. All three stages are of central importance for the evolution of local industries and are explicitly linked to the concept of path dependency. These three stages of evolution of a local industry are strongly related to the stages of the product and industry lifecycle: introduction, growth and mature (e.g. Utterback, 1994; Covin & Slevin, 1990). These lifecycle stages have been adapted for illustrating the lifecycle of local industries: the entering of new knowledge, the formation of a new industry, and the anchoring process of a new local industry.

First, local economies are never static, but are evolving to some extent continuously (Martin & Sunley, 2007; Boschma & Lambooy, 1999). New combination of knowledge is an important driver for the evolution of local economies and emergence of new local industries. One important aspect linked to the evolution of local economies and local industries is therefore how new knowledge is entering and spread in the region (Audretsch & Keilbach,

2004; Dosi et al., 1995). In literature it is often analysed in what way this new knowledge is related to the existing knowledge in the region and why this knowledge in particular entered the region (Boschma & Iammarino, 2009; Boschma & Frenken, 2009).

Second, the emergence of a new industry is another important aspect in the evolution of local economies. While the evolution of local economies is a continuous process, new industry emergence opens up a potential new direction of the regional path. Not all new knowledge, however, leads to the emergence of a new local industry. For a new local industry to emerge, the number of companies which can translate new knowledge into new business ideas needs to increase and concentrate in the particular location (Bresnahan et al., 2002; Malerba & Orsenigo, 1994; Aldrich & Fiol, 1994). Also here one important question is how this new industry relates to the existing one and what mechanisms lead to the formation of a new local industry.

Third, another important aspect is the question how the new industry is anchored in the region and thereby becomes legitimate (Klepper & Thompson, 2006; Feldman, 2003). The entrance of a new industry will always, in one way or another, disturb the existing local structures. On the other hand, the existing structures might shape the new local industry. This mutual influence is interesting to analyse.

The entering of new local knowledge

'New combination of knowledge' (Schumpeter, 1934: 65) is often the foundation of new industries. This new knowledge enters the region in two ways: Either it is generated locally or it enters from outside. In most cases, the new knowledge is not created locally in the region, but enters the region through different channels: An existing firm might open up a new plant or office in a region, people might be moving to another region and bring new knowledge with them, trade activities might stimulate the exchange of knowledge as well as new knowledge can enter the region through global networks of various kinds. Once new knowledge entered the region, local individuals will create new combinations of existing

knowledge. Research has been drawing attention to the importance of networks for innovators, firms and entrepreneurs (Witt, 2004; Wilkinson & Young, 2002; Freeman, 1991). Granovetter (1973) stresses the importance of weak ties for the diffusion of innovation.

Dosi et al. (1995) found that incumbent firms are an important source for the creation of new knowledge. Incumbent firms might be operating in another industry but wish to diversify. Often, this diversification occurs through acquisition. Especially if the industry is rather young, the involvement of large firms might give an extra push. This is in line with Penrose (1959) who suggested that the turnover of a single product is limited by the consumer demand for this specific product. Conclusively, the growth of a firm requires a firm to diversify in other products (Frenken & Boschma, 2007; Chandler, 1962). In that sense, when the firm is acquiring new knowledge, this can mean that new knowledge is entering the region in general.

Nonetheless, Audretsch and Keilbach (2004) suggested that also entrepreneurship is an important mechanism in creating a diversity of knowledge. They argue, based upon Arrow (1962), that if incumbent firms do not commercially exploit generated knowledge, but other economic agents do, these economic agents become entrepreneurs and contribute to a diversification of knowledge. In other words, entrepreneurs act upon certain knowledge which has not been valued high by incumbent firms. Thereby, the entrepreneurs can bring new knowledge into the region. Audretsch and Keilbach (2004) do not elaborate why certain knowledge is not valued by incumbent firms. There might be several reasons for that: first, the incumbent firms might not see the business opportunity (Christensen, 1997). Second, the market is not large enough to be profitable for a large firm. Third, the business opportunity might be outside of the incumbent firm's core competences (Prahalad & Hamel, 1990). Finally, the not-invented-here syndrome might be a barrier, where the firm simply refuses to make use of knowledge with external origin (Katz & Allen, 1982).

Universities are also important sources for new knowledge creation. Although to be considered as a phenomenon specific to North America, the exploitation and diffusion of public research can be seen in any advanced economy (Clarysse et al., 2005). The shift from the ivory tower to an entrepreneurial university in the late 20th century strengthens the role of the university as a creator of new knowledge (Etzkowitz et al., 2000).

Independently of the discussion about who the actors are, be they entrepreneurs, universities or incumbent firms, an extensive research stream has been dealing with how such new ideas and products relate to the existing knowledge of a firm or a region. Cohen and Levinthal (1990) suggest that the ability to absorb new knowledge depends highly on the firm's prior knowledge. In that sense, a certain path dependency has been acknowledged where a certain pre-understanding is beneficial for further knowledge creation. Biotech companies are more likely to generate new knowledge related to the biotech industry than any other industry. It should however be kept in mind that many inventions and innovations are used in a different way than they were intended.

The main idea behind the concept of absorptive capacity can be seen in the concept of related variety (Boschma, 2008). The related variety concept suggests that new knowledge emerges out of existing, related ones (Boschma & Frenken, 2009). Learning processes and knowledge accumulation steer the companies and the regions in a certain trajectory. Boschma and Iammarino (2009) showed that an inflow of knowledge *per se* did not affect economic growth of regions between 1995 and 2003, but that the knowledge needed to be related to the existing ones. Other research showed that one needs to differentiate between the different development stages of industries. New (high-tech) industries benefit more from inter-industry knowledge spillovers, while more matured industries need intra-industry spillovers (Neffke et al., 2011). In that sense, depending on the development stage of the industry, there might be different dimensions to 'relatedness'.

Formation of a new local industry

Once new knowledge entered the region, a new industry might emerge, if the number of incumbent firms or start-ups engaging in similar activities increases. Schumpeter (1934) referred to this phenomenon as 'swarms of imitators'. New companies are recognized to play an important role in the formation of new industries (Malerba & Orsenigo, 1994; Aldrich & Fiol, 1994). Bresnahan et al. (2001) suggest that the creation of new firms is one critical factor for the agglomeration of firms within the same industry. Formation of new industries is however characterized by turbulence where the entry and exit of start-ups is rather high (Dosi et al., 1995). Andersson and Koster (2011) present evidence of spatial-temporal persistence in start-up rates. Two mechanisms are distinguished: the stickiness of factors influencing the start-up rates (spatial persistence) as well as the path dependency in start-up activities due to demonstration effects (spatial and temporal persistence). If the creation of new firms is vital for the formation of new industries, this might suggest that new industries are more likely to emerge in entrepreneurially active regions.

Entrepreneurship is not simply a result of a larger number of opportunities (Shane, 2003), but much research has been done on the importance of entrepreneurial role models (Aldrich, 1999; Arenius & Minniti, 2005; Henrekson & Stenkula, 2007). High startup rates over a long period of time may lead to the development of a positive attitude towards entrepreneurship resulting in supporting formal and informal institutions (Shapero & Sokol, 1982; North, 1990). Role models might not only open up the possibilities about entrepreneurship in general, but open up more specific possibilities within a particular industry. Buenstorf and Klepper (2009) and Klepper (2007) stress the role of spinoffs in new industry emergence. Buenstorf and Klepper (2009) showed that by historical accident Goodrich located in Akron to produce bicycle tires and, later on, the first pneumatic automobile tyre. Swarms of imitators emerged as Goodrich's company became more and more successful. This swarm behaviour is often localized, because knowledge spillovers are often geographically bounded (Audretsch & Feldman, 1996b). Localized swarming behaviour, localized knowledge spillovers and

localized spinoff behaviour suggest that the region might become more and more specialized and thereby develops along a certain trajectory. The related variety concept suggests that it is easier to spill over knowledge to other firms which possess related knowledge (Boschma, 2008). In that sense, *'industries are more likely to enter a region if they are technologically close to the regional portfolio.'* (Neffke et al., 2009: 31)

Also universities have been acknowledged as one important source of new technology-related firms (Peréz & Sanchéz, 2003). Research at universities creates new knowledge, which might be used by private companies and even might result in university spin-offs. University spin-offs, in comparison to corporate spin-offs, are more often based on technological advances rather than on pre-assumed advantages on marketing or sales. Founders are often scientists and engineers who want to explore new technologies more freely rather than to test their entrepreneurial abilities (Dahlstrand, 1997). In that sense, university spin-offs with their focus on technological advances are important actors to push the boundaries of new industries.

Anchoring process of a new local industry

The survival of the new local industry depends on how it is anchored in the existing regional structure. Feldman (2003) introduced the so-called anchor hypothesis where existing firms serve as anchors for new industries. It is suggested that single, large existing firms are of greater importance for the anchoring process than a group of smaller ones. It is furthermore suggested that the profile of the existing anchor is of crucial importance for the specialization of the start-ups. This implies *'a regional path dependency that stems from the existence of the anchor firm to the specialization of new firms that enter the industry in that location'* (Feldman, 2003:3). This regional path dependency occurs because the anchor establishes skilled labour pools and provides knowledge spillovers for new technology-intensive firms in the region. Orlando (2000) and Autant-Bernard (2001) propose that benefits of knowledge spillovers are higher for similar applications. Conclusively, to some extent, the anchor

determines the technological development trajectories leading eventually to a specialization of the newly emerging industry. It is however not discussed how and why existing firms might turn into new directions and thereby turn into anchors for new industries.

Also Klepper and Thompson (2006) acknowledge the role of large companies in the local legitimization of the new industry. They developed a theory of spinoffs suggesting that spinoffs are the result of strategic disagreement within firms. The theory suggests that *'the more successful the firm then the greater its expected rate of spinoffs and the better the expected performance of its spinoffs'* (Klepper & Thompson, 2006:619). It is also pointed out that spinoffs tend to be located in geographically close proximity to their parent firms. Consequently, a region with one or several superior firms will eventually have an increasing number of superior firms through spinoffs which will lead to an agglomeration of economic activities. Boschma and Frenken (2006: 279) argue similarly as *'success breeds success through learning'*.

This theory of spinoffs was later used to explain the agglomeration of the U.S. automobile industry around Detroit (Klepper, 2007) and the clustering of the U.S. semiconductor industry in Silicon Valley (Klepper, 2010). It remains rather unclear how these superior, or successful firms were identified, but it can be assumed that a successful firm produces a relatively large amount of cars compared to its competitors. But no concrete criteria have been provided for how the leading automobile firms and semiconductor producers have been identified (Klepper, 2007, 2010). Klepper (2007) explains the agglomeration of the automobile industry around Detroit by noting that the four most successful entrants could be found in and around Detroit and that they had a higher spinoff rate and spun out better-performing spinoffs. It remains however unclear why the four most successful early entrants could be found in Detroit and were not spread throughout the U.S. While Klepper explains the self-strengthening effects, he does not discuss the initial starting events of this whole process. *'The leading firms, which are disproportionately concentrated in the Detroit area, spawn spinoffs*

at the highest rate' (Klepper, 2010: 22). There are however also other examples where spin-offs from unsuccessful companies marked the starting point of a new industry. In the case of the semiconductor industry, Fairchild, an important company for the success of the semiconductor industry, spun out of Shockley Semiconductor Labs, a company which never produced a commercially successful product. But also this case is a good example of strategic disagreement. (Holbrook et al., 2000)

Table 1 synthesises the theoretical discussion by providing a short overview of the three stages of local economic development and their description.

Insert table 1 about here

METHOD

To illustrate the potential three evolutionary stages of local industries, the case study of Linköping has been selected for several reasons. First, Linköping underwent a remarkable transformation during the past century from a small town of rural character into one of the largest cities in Sweden. Second, Linköping's entrepreneurial phenomenon is known throughout Sweden. Entrepreneurial activities are a central part of this success story leading to the emergence of the local IT industry.

Data collection

Data consisted of interviews, field research, organizational documents and media reports. Several chronicles described the historic development of Linköping and enabled to go further back in time than interviews alone would have allowed (Lokalhistoria, 1999; Knuthammar 1994; Hellström, 1983; Almroth & Kolsgård, 1981). All together 14 semi-structured interviews have been conducted, averaging between 90 and 120 minutes each. Interviews were conducted in 2011. All interviews have been transcribed shortly after the interview took place. Interview partners were mainly entrepreneurs who started knowledge-intensive companies in Linköping during the past 30 years. Several employees from the municipal administration, and other relevant organizations, such as investment agencies and the

university, have also been interviewed. Several representatives from SAAB, which is the largest private employer in Linköping, have also been interviewed. It was also important to interview other researchers in order to be able to collect further in-depth information.

It should also be noted that many interviewees had changing roles throughout the decades: entrepreneurs later became local investment managers, university employees became entrepreneurs. Interviews provided insiders' views on the local transformation process and the motivation behind events, and are therefore subject to retrospective biases. Much of the case discussion is based on the interview data.

Data analysis

In accordance with the aim of this paper, the analysis is concerned with understanding how the local economy evolved over time, why it evolved in this way and who the actors were. In accordance with recommendations for process research (Zietsma & Lawrence, 2010; Langley, 1999), different analytical stages were designed. First a chronological list with events and activities has been constructed. Then, a narrative has been composed containing all the interview data. Third, the study's boundaries have been identified in accordance with the research question and the literature review. Thereby, the relevant events were identified. Fourth, the relations between the relevant events and its actors have been identified. Thus, it was closely examined which events resulted in other events and who the actors were. Finally, based on these steps of the analytical process, the narrative has been rewritten according to the structure in the literature review in a condensed form as seen in the following section.

LINKÖPING'S TRANSFORMATION

In the 12th century, the Catholic Church built a cathedral and from that time on, Linköping played an important role as a centre of education and public administration (Lokalhistoria, 1999). In 1627, Linköping was the third town in Sweden which acquired a high school. The former cathedral school was converted and the school was soon known throughout the country (Hellström, 1983). Despite its importance for the church and education, Linköping

remained a small town of rural character with no noteworthy industry before the 20th century. Nowadays, however, Linköping is well known as the *'Swedish aviation capital'* and for its *'entrepreneurial spirit'*. This transformation will be analyzed according to the theoretical framework.

The entering of new knowledge

New knowledge entered the region through an historical accident. In 1907, the Uggla brothers Carl Johan and Erland decided to quit their jobs as engineers at Södertälje Workshop and moved to Linköping to establish the private Swedish Railroad Shop (ASJ). After the First World War, cars and trucks started to compete with railroads and busses and the company was forced to search for new products (Almroth & Kolsgård, 1981). The first airplanes were developed and manufactured in the beginning of the 30s. Manufacturing steel bodies for trains and busses was at that time not so different from manufacturing bodies for airplanes. It was rather common that train and car manufacturers produced bodies for airplanes during the 20s and 40s. The aviation division was soon bought by SAAB AB in 1939, which located its own airplane manufacturing in Linköping after that. Another historical accident was the government decision which led to the establishment of SAAB AB. SAAB AB was created in 1937 with Europe being on the brink of a major conflict. SAAB AB was established through state intervention but in cooperation with leading industrialists such as the Wallenberg family from Stockholm. The company should secure Sweden's neutrality and supply of military aircrafts.

With SAAB, the first large-scale production entered Linköping (Almroth & Kolsgård, 1981). SAAB developed quickly into the largest private company and still is today. Hence, the establishment of ASJ and its purchase by SAAB proved to be of immense importance for Linköping's development. The development of airplanes progressed quickly which meant an increasing demand for electronic products. In the 50s, SAAB intended to develop a navigational computer for its fighter jets. The navigational computer was used in the fighter

jet ‘SAAB 37 Viggen’ which was introduced in 1971. The navigational computer could be easily transformed into mini and mainframe computers for civilian use. Furthermore, computers were needed to cope with the increasing demand for design calculations. Conclusively, the SAAB computer division was born and was spun out later on as Datasaab.

As a military company, SAAB AB was a national company with a rather closed network. This might be one reason for the traditionally low number of spinoffs. Beside Datasaab, there was basically no other spinoff until the 80s. Nonetheless, much knowledge has been spilled over from the military aircraft industry to civil application areas. It was however not SAAB, but SAAB’s national cooperation partners such as Ericsson, which turned knowledge into products for the commercial market (Eliasson, 2011).

While the local knowledge spillovers have been traditionally weak, SAAB played an important role in bringing the university to Linköping (LiU) in 1969. The establishment of LiU was made possible by a national decision which was beyond the control of the local and regional authorities and thereby was another historical accident of immense importance for Linköping’s development. The baby boom after the Second World War led to an increase in the number of students in the 60s. The Swedish government decided to establish more higher education institutions and many municipalities tried to attract such an establishment. In Linköping, several individuals were interested to attract an establishment of higher education. SAAB director Lars Brising and civil servant Samuel Bergbäck suggested the establishment of a technical college with strong links to the regional industries. First a technical college, it was granted full university status in 1975. Being aware of SAAB’s central role, the vice-chancellor of LiU, Hans Meijer, knew that the university’s success was dependent on a close collaboration between SAAB and LiU. At that time, the pre-dominant agreement in Swedish academia was that academia and industry should be kept apart. LiU therefore needed to go against this agreement, if strong ties with the regional industry were something to strive for. The vice-chancellor recruited new professors, such as the new professor of image processing

Ingemar Ingmarsson and staff which were known for their relations to the industry. These employees came mainly from established universities, such as from Stockholm, Uppsala and Lund, and have had enough of academia as an ivory tower.

Furthermore, the success of LiU was also dependent on how well this new organization was integrated in the existing economic structure of Linköping. SAAB as the largest private company had a strong influence on the university's profile. Datasaab was rather successful at that time and LiU acquired Sweden's first IT professorship accordingly. Soon, SAAB donated a used model of its D21 for educational use. The local IT activities were therefore related and unrelated at the same time: it was rather unrelated to the history of the location, but related to an isolated activity at SAAB AB. The university opened up this particular knowledge to others outside of SAAB AB. The ties with the university were weakened due to the sale of Datasaab to Ericsson and the emergence of an entrepreneurial university focusing mainly on entrepreneurship. While Datasaab failed, it was important for the future development of the local economy.

Audretsch and Keilbach (2004) suggested that entrepreneurs are important for the diversification of knowledge and that they act upon certain knowledge which has not been valued highly by incumbent firms. The entrepreneurs in Linköping stressed the uniqueness of their product. Often, their product was described as very 'odd'. This suggests that the market for such kinds of products was small at first and not profitable for large companies, but profitable for start-ups. Conclusively, in the case of Linköping, entrepreneurship was an important mechanism in creating a diversity of knowledge. While SAAB and Datasaab were important players at first to bring new knowledge into the city, the entrepreneurial activities of start-ups diversified the knowledge into odd products.

Formation of a new industry

Such entrepreneurial activities were very important for the formation of a new industry. Bresnahan et al. (2001) suggest that the creation of new firms is one critical factor for the

agglomeration of firms within the same industry. In the 80s, the IT industry was rather young and had remarkable growth rates not only in Linköping, but also on the global scale. The vast majority of local start-ups occurred in the IT industry and thereby reflected the technological profile of the university. Due to high turbulence in the newly emerging IT industry, the entry and exit of start-ups were rather high. Despite the high number of exits, new IT companies started to emerge. As a new industry with high growth rates, a lot of opportunities existed. These growth rates meant that it was apparently difficult to fail, if one took work seriously. LiU was not a large university at that time with only a few departments. In the beginning, many start-ups were spin-offs from the department of image processing. In 1979, Sectra AB was started by Professor Ingemar Ingmarsson and three of his PhD students: Viiveke Fåk, Robert Forchheimer and Rolf Blom. The reason behind this start-up was that the university research group was approached by a large number of private companies. These projects from private industry were very practical oriented and the research group was drifting further away from academic research. The idea to found Sectra was born. Ingmarsson, Fåk, Forchheimer and Blom could now take care of practical projects outside of the university. The establishment of Sectra proofed to be a role model for other employees. Shortly after, Björn Krause started Imtek AB, Gösta Granlund and Sven-Günther Hanssen started Contextvision, Bengt Sandlund started IDA Infront AB, just to mention a few. In the beginning of the 80s most of the staff in the department was to some extent involved in different spin-offs. Interestingly enough, the entrepreneurs did not speak about their companies with their fellow university staff, but they were considered as serious competition. In some cases, a lot of money was at stake: companies, such as Imtek AB and Contextvision AB, became practically overnight multibillion SEK companies. This opened up the eyes of staff at other departments to identify and exploit business opportunities. While the first university spin-offs were started by the staff, also the students soon became entrepreneurs. Some of the first student entrepreneurs were Bengt Nilsson and Lars Karlsson who founded IFS AB in 1983, Björn

Algkvist, Mikael Ageras, Göran Felldin and Rune Groppfeldt who founded Intentia in 1984. Due to the size of the university, the number of students was small and everybody knew everybody. The founders of Intentia and IFS lived in the same student corridor. Also the girlfriends started companies: Anna-Carin Månsson, for example, started Exit Marketing AB in 1984. During the interviews, the uniqueness of the education during the 70s and 80s was stressed. In that sense, the job market was not yet ready for such a type of employees. The increasing importance of IT for all industry sectors meant that it was easy to find a job, but these jobs often did not involve the same degree of newness as the education was all about. Instead of settling for a minor interesting job, many students were inspired to start up new companies developing products which were, due to their innovativeness, considered to be rather 'odd' at that time. Pioneers like the Uggla family, Lars Brising and Hans Meijer created a favourable environment and the entrepreneurs took the opportunities. Hence, entrepreneurs were the actors driving the success story of Linköping in the 80s.

Andersson and Koster (2011) present evidence of spatial-temporal persistence in start-up rates. Until the beginning of the 80s, the start-up rate was rather low in Linköping. Nonetheless, Linköping is now known for its entrepreneurial spirit in Sweden. This break was a result of the establishment of a university; a university which had a positive attitude towards entrepreneurship. First start-ups were established by the staff, but a couple of years later also students created new firms. The IT cluster in Linköping was not created by incumbent firms moving to Linköping, but through the establishment of new local IT companies; employees and students who moved to Linköping for the job or education and decided to stay. LiU was important in order to attract young people and turned them into entrepreneurs. Therefore, Linköping seems a logical choice for the location of the university's spin-offs.

The spatial and temporal persistence in the Linköping start-up rates can be explained with the increasing numbers of role models. While the first entrepreneurs in the 70s and 80s were a rather new phenomenon to Linköping, the actual *persistence* in start-up rates can indeed be

explained with role models. Two activities were of rather central importance for the formation of an entrepreneurial environment. First, the vice-chancellor was successful in attracting scholars who had a positive attitude towards cooperation with the private industry. Second, the active encouragement of the university employees to engage in entrepreneurial activities was another initial spark for the future entrepreneurial development, which eventually resulted in the formation of the local IT industry. The early entrepreneurs were later on advisors for investment companies or board members of other start-ups. In that sense, the early entrepreneurs were not simply doing their business, but were incrementally changing the local business environment to fit their needs and the needs of the younger generation of entrepreneurs.

As a result of an increasing number of entrepreneurs, an entrepreneurial support structure started to form. Many organizations were established with the goal to support entrepreneurs in their new activities. This newly emerging local entrepreneurial support structure contributed to a limited extent to the spatial and temporal persistence in the local start-up rates. The story about the local IT industry formation is pretty much a story about a few entrepreneurs. During the interviews with the entrepreneurs it was stressed that they only received limited support from public organizations in the beginning. But it can be stated that the establishment of the Mjärdevi Science Park was important for the start-ups because cheap, small and flexible offices could be offered to the new entrepreneurs. In that sense, the entrepreneurial support structure had some impact on the entrepreneurial activities.

Anchoring process of a new local industry

The local entrepreneurial support structure did play a certain role for the formation of the new IT industry, but it was more important for the anchoring process. Anchoring process here means the total of processes that turned the newly emerged industry into an established industry in the city.

In the case of Linköping, this can be observed clearly. SAAB was and still is the largest private employer in Linköping and is very research-intensive. SAAB's need for a navigational computer led to the formation of a computer division, which again resulted in the first IT-professorship in Sweden. SAAB was bringing this new knowledge into the region and the success of Datasaab in the 70s contributed to some kind of legitimization of the local IT industry. The profile of the anchor is of crucial importance for the specialization of the start-ups (Feldman, 2003). In the case of Linköping, it holds true as well even if the mechanisms are not very clear-cut. Datasaab was focusing not on application software, but on the program codes behind it. As a result the education at LiU was created accordingly. As most of the start-ups are founded by employees and former students, also the local IT cluster does have a unique profile. While the IT companies in Stockholm are nowadays considered to work with Internet-related applications and games, there is still a much stronger focus on the program codes and the technique in Linköping. It was mentioned that this specific profile in Linköping was one reason why the local IT cluster could cope much better with the IT crashes in the 90s. Web-related products, such as apps, are a matter of fashion and trends which can change very quickly. But the technology behind IT is a basic foundation which is always required. In that sense, Datasaab's legacy can be seen today in the profile of the IT cluster and the IT start-ups.

Klepper and Thompson (2006) acknowledge the role of large companies in the local legitimization of the new industry through spinoffs. This cannot be observed in Linköping. SAAB as a defence and security company produces products mainly for military use. Conclusively, the company was a rather closed company and the spinoff rate has been traditionally very low. From the mid-80s onwards, the numbers of SAAB spinoffs increased. This might be a result of the increase of entrepreneurial activities in Linköping in general. Local role models might have been stimulating also for SAAB employees and not only for university employees or students. Another reason might be the corporate efforts to turn the company from a closed national company into a more open international company. In that

sense, SAAB was becoming more active in commercializing military products and technologies on the commercial market. Military products can often easily be turned into products for non-military use; e.g. a radar altimeter for missiles was developed further into a tanker level-gauging system measuring the level of liquids in a closed tank and resulted in the SAAB spinoff SAAB Marine Electronics. While the number of spinoffs increased in the past 20 years, the spinoffs are not centred on a certain industry, as seen in Table 2. In that sense, SAAB spinoffs originating from Linköping did not contribute to the anchoring process of the local IT industry.

Insert table 2 about here

While the company played a significant role in attracting the university and for the university's profile, it has been the university itself which produced the spinoffs that resulted in the formation and later anchoring process of the local IT industry. Conclusively, SAAB had a more indirect impact on the anchoring process of the local IT industry due to the closure of Datasaab and the closed nature of the defence company SAAB AB.

Since the 80s, the number of start-ups increased steadily and reached its temporary peak with 932 start-ups in 2011 (Bolagsverket, 2012). Never before have so many businesses launched in one year. The entrepreneurial spirit in Linköping seems to be pretty much alive until today. The increasing number of university spin-offs did not pass the public authorities unnoticed and especially in the 80s and 90s most of today's entrepreneurial support organisations emerged: Foundation for Small Business Development (SMIL), InnovationskontorEtt, Exportrådet, Innovation Bridge, Teknikbyn, Center for Innovation and Entrepreneurship (CIE), LEAD Incubator, Novare, ECI, Linktech, University Holding AB and so on. Many of the entrepreneurs from the 80s and 90s are now working as consultants for these organizations, such as Göran Felldin, Pahl Mellin and Lars-Erik Nordell. This can be seen as an important step for the anchoring process of the local IT industry. Special entrepreneurship programmes were provided at the university and venture capital entered Linköping.

Generally, entrepreneurs had now someone to turn to. Many entrepreneurial support organisations are now involved turning entrepreneurial activities into a very formalized process. This also means that entrepreneurs turned from pioneers into the norm: not wanting to be an entrepreneur is now considered to be strange.

The importance of the local entrepreneurial support structure increased during the anchoring process of the local IT industry. While the support organizations played a rather insignificant role in the formation process, they were important for the anchoring process.

CONCLUSION

This study discussed the evolution of a local industry in Linköping. The analysis of the local evolution included also the small 'historical accidents' which actually broke down barriers and opened up the entrepreneurial path. In doing so, this study took a more comprehensive view of the evolution process than past studies. In the literature, many studies focus on the spatial and temporal persistence of success and conclude with statements like *'nothing breeds success like success'* (Boschma & Frenken, 2006:279) and *'successful companies tend to spin-off successful companies'* (Klepper, 2007:619). Often the initial historical events which initiate the success stories are exogenous to the theory and, hence, contribute little to a detailed clarification of why some regions become successful in the first place.

However, some problems remain unsolved. The question why some regional economies become locked into development paths where some lose dynamics over time and others have the ability to reinvent themselves through new paths is only partly answered. The case of Linköping showed that small 'historical accidents', such as the establishment of the AJS, proved to be the initiating spark of what later became known as the 'Linköping success story' (Klofsten et al., 1999): a university town with a large share of knowledge-intensive small and medium-sized companies. The term 'small historical *accidents*' suggests that the starting points of such success stories are somewhat random and at best very difficult to encourage

and steer. Path dependency also stresses that *small* accidents can gain in importance over time. Back in 1909, no one could imagine that the economic activities of the Uggla family would be the starting point for the national aviation and local IT industry. This means that accidents are difficult to create and that it is difficult to predict the importance of every current small accident for future development. In retrospect, the path can be identified, but it is difficult to predict. The case of Linköping showed that beneficial circumstances, unique individuals and a bit of luck might be the starting point of unexpected processes.

Historical accidents might also suggest that these events do not need to be related to already existing local activities. In the case of Linköping, the emergence of the local IT industry was initiated by historical accidents, such as the start of ASJ and the establishment of the university. Historical accidents which are unrelated to existing local economic activities opened up the possibilities for a new local path. The initial events might have been unrelated and driven by pioneers, but the followers and their related activities pushed into a certain trajectory. The case discussion showed that the region developed along a certain path, where one event resulted in another and thereby pushed the local economy into a certain trajectory. In that sense, the historical accidents got strengthened by the many activities of individuals pushing into a certain trajectory

The main driving forces of the local process were individuals, SAAB AB, the university and the local support structure. As seen in Table 3, the relative importance of these driving forces differed throughout the different development stages: entering of new knowledge, formation of a new IT industry as well as the anchoring process of the new IT industry.

Insert table 3 about here

The activities of several individuals were the initial sparks for bringing new knowledge into the region. First, the Uggla family opened up the possibility for SAAB AB to come to Linköping. Second, SAAB director Lars Brising was actively involved in bringing a university to Linköping. Third, the university vice-chancellor Hans Meijer succeeded in

creating a university with strong connections to the local industry and hand-picked employees with connections to the private industry. These individuals can be called pioneers who laid down the ground and opened up the path for entrepreneurial activities.

The formation of a new local IT industry was dependent on the university's technological profile and the entrepreneurial-friendly climate at the university, which inspired staff and students to start up IT firms. Stories about the beginning of the entrepreneurial success stories put the activities of entrepreneurs in the focus of attention. While the first entrepreneurs can also be described as pioneers breaking down barriers, the formation of the new local IT industry relied on entrepreneurial followers. This means that the creation of a resource-pool, such as the creation of knowledge as well as motivated people equipped with this particular knowledge, was needed or otherwise the evolution would have come to a stop before it even started. The actions of public authorities were described as helpful at best, but were not considered to be of great importance for the formation of the local IT industry.

The actions of public authorities resulted in an elaborate support structure which played an important role in the anchoring process of the new local IT industry. An infrastructure was established to support the entrepreneurs. Actions of the individuals are still important, but are less obvious. The entrepreneurs turned from being rare into the norm. With an increasing number of entrepreneurs, the stories are now less about individuals and more about the entrepreneurial spirit of Linköping. It was also shown that neither SAAB nor its spin-offs played a direct role in the anchoring process. This might be due to SAAB's exceptional role as a defence company which just recently started to open up and diversify in the civilian market.

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Table 1: Three stages of local industry development

Stage	Description of the stage
Entering of new knowledge	As new knowledge should be understood knowledge which has not been present in the location, but entered the region through different channels. Such channels can be global networks, mobility of firms and people as well as trade. In most cases, this new knowledge is not locally created.
Formation of a new industry	New knowledge, whether completely new or a new combination of existing knowledge, will lead to the formation of a new industry if there is a critical mass of local entrepreneurs or incumbent firms which take actions within a similar business area.
Anchoring of the new industry	With an increasing number of actors, this new industry will then be anchored in the existing profile of the local economy. The anchoring process is the process that turns the new industry into an established industry in the local economy.

Table 2: SAAB spinoffs originated from Linköping between 2001 and 2010

Spinoff	Product
Sanguistech AB	systems for blood centrifuging
HS Memory AB	high-speed memory architecture for military radar applications
MX Composites AB	high performance components
SMM Medical AB	compression device for the treatment of vascular disorders
Tracab AB	Image Tracking System
A2 Acoustics AB	Active sound control
Efield AB	electromagnetic simulation system
Minesto AB	tidal energy kite
C3 Technologies AB	3D mapping

Table 3: Driving forces in the different stages

Stage	Driving forces
Entering of new knowledge	*Pioneers:* Uggla family as entrepreneurs, SAAB director Lars Brising, university vice-chancellor Hans Meijer
Formation of a new industry	*Followers:* Entrepreneurs who were university staff and former students, such as Forchheimer, Felldin, Nilsson, and so on.
Anchoring of the new industry	*Infrastructure:* Public support structure

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