LUND UNIVERSITY
School of Economics and Management

Actors in Innovation

- Testing the "lone inventor" narrative

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Bachelor's Thesis , 15 ECTS
August 2016

A B S T R A C T

Innovation is gospel today. This also means a surge in popularity for the agents behind innovation; innovators. But who are they, exactly? Anecdotal evidence from both recent times and historical settings tend to emphasize remarkable individuals, who more or less alone created amazing things. By utilizing the SWINNO-database of innovations, this thesis examines how empirically prevalent the narrative of the lone innovator is in the Swedish telecommunications sector. The material consists of cases of innovation from the period 1970-1990. The inventors behind the innovations are classified on account of their organizational circumstances, to see if independents are important contributors to Swedish innovation. The inquiry finds that the absolute majority of innovations are the fruits of firms and employees. They accounted for 84 % of all innovations, whilst the independents were behind 16 %. This inquiry also found that the share of innovations developed by independents was stable from the early to the later part of the period studied. This inquiry also tried to find out if the independents in the material were mostly "inventor-inventors" or "inventor-entrepreneur" types. The results showed the latter is more common and has become increasingly so over time.

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1. Introduction

Much like innovation itself, the innovator has remained a somewhat elusive figure in economic theory. Yet the popularity of the creative genius seems to rival that of movie stars and sport heroes today. The innovator is everywhere, both as an economic phenomena and social role model. Journalist Zeynep Zileli describes in an article named "The Cult of Innovation" our idolization of innovators as a new "cultural aspiration" and submitted some recent influential movies as evidence, amongst them "The Social Network" depicting the history of the founder of Facebook and "Jobs", the portrait of Apples legendary leader (Zileli 2013). These references could be supplemented by for example shows like "Shark Tank" and "Dragons Den" which similarly pushes the narrative of one brilliant person with one brilliant idea receiving a fortune in financing and having his luck made. This canonization of innovators is not unique for our time - the inventor cult of the late 1800s gave birth to its faire share of stars. Both the historical and contemporary examples have in common their emphasis on the person, the talented individual as a source of innovation. For this thesis, I was inspired by the above mentioned stories of creative geniuses; remarkable individuals that develop and commercialize innovations. Is this a reasonable way to think about innovation? Is this how it happens? How common is the lone innovator as a source of innovation? Clearly, this is a perspective in which the agents behind innovation - innovators - become central. Relating to that subject, the interest of this thesis is to research the circumstances in which they innovate and the purpose is to study innovation processes to see if the *narrative* of the individual initiative is *empirically prevalent.*

2. Background of the inquiry

According to Google's function Ngram Viewer, which tracks the prevalence of a word in print over time, the use of the word "innovation" has increased rather virtuously since the 60's (Google 2013). And pop culture does not account for all of that. Senior editor at the New Republic, Evgeny Morozov, writes in an article titled "Our Naive 'Innovation' Fetish" that politicians "left, right and center" have been mesmerized by the buzzword and its seemingly endless possibilities (Morozov 2014). He finds that the moldable concept of innovation appeals to all camps on account of its connotations to freedom from existing, restricting structures. This is why, in policy discussions, innovation is used as an all-curing remedy for the most diverse of issues. Such is also the case in the academic context. Perhaps one can, like economics professor Paul A. David, fear that an innovation fetish has ravaged economic

research to the degree that the phenomena has been assigned every beneficial quality ever thought of, with little regard for empirical proof and critical assessment (David 2012). The fascination with innovation has instead acquired increasingly "reverential overtones". The author hence concludes that instances of "magical thinking" surrounds some innovation theories.

The breeding ground of this mysticism is almost certainly the still remaining question marks within innovation theory. The buzzword nature of the concept is also why innovation can seemingly with ease lend itself to many different groups and causes. To narrow the gaps it is imperative that further study is undertaken. But studying innovation is a complex and broad task. For one, innovation is in the context of economics understood as a process including several steps, out of which all must be accomplished for it to constitute a complete case of innovation. These steps can be delimited to idea generation, development and introduction to market (even though the process may not be executed in such a linear fashion) (Pavitt 2005: 95). Studying innovation could thus mean focusing on any of these phases and any aspects thereof. For this thesis I am focusing on questions concerning the origin of innovation; the starting point, the conceiving of a purpose and the initiative to fulfill it. The aspect I am concerned with is the agent, the person or organization, responsible for innovation.

Per Frankelius and Charlotte Norrman published in 2013 a study commissioned by Svenska Uppfinnareföreningen on the situation for independent innovators in Sweden. They introduce their discussion by describing how inventions, and in connection to those, the inventors or innovators held a more clear center stage in the innovation discussion during the late 1800s and the beginning of the 20th century, than it does today. Now, this discussion is more geared towards the "innovation system" perspective (Frankelius & Norrman 2013: 15). The authors point out that the current direction may have created a sentiment that the lone inventor is a thing of the past, and even a myth that should be killed. Perhaps as a consequence of this tendency, the study finds that independent inventors are likely to be unable to draw support from existing innovation support systems, as they are not the primary target of these (Frankelius & Norrman 2013: 167). Frankelius and Norrman also finds that independent innovators contribute significantly to Swedish innovation and should therefore not be neglected. For the purpose of the study the authors have created a scheme for classification of inventors based on their organizational context (Frankelius & Norrman 2013: 44). With this they singled out a target group of independent innovators for the study, who are commercializing their innovations either via a company of their own or by licensing or

selling their innovation, thereby commercializing it without starting a firm for the purpose. They call the first kind *entrepreneurial inventor* and the second kind *inventor-inventors*. They also emphasize the variety of actors that can be found within these categories. This study, as it ties in to the aforementioned examples of heroic innovator tales, further inspired me to focus on the same type of innovation agent as Frankelius and Norrman: the independent or lone innovator. I would like to study how common these actually are in Swedish innovation activity. To do this, I will use the scheme of Frankelius and Norrman to classify cases from a selection of innovation cases.

In another study, Christer Sandström investigates the origins of a selection of 100 of the most important Swedish innovations. His study is also concerned with the question of how to organize innovation policy and innovation support to gain the most results (Sandström 2014:3). He has a similar emphasis on specifically the organizational circumstances of the innovators. Consequently, he divides innovators into three categories; 1) employees at a firm, 2) employees at a university or 3) independent. Sandström cites the above mentioned work by Frankelius and Norrman, and describes his classification as based on their scheme. He finds that indeed, independent innovators have contributed significantly to Swedish innovation activity. 33 % of the 100 innovations were created by this category; quite a bit more than university employees who was responsible for 20 % of the innovation. Sandström also finds there are substantial differences between sectors. The independent innovators seems to be the most important in the ICT-sector (Sandström 2014: 7). This finding of Sandströms has influenced the selection of material for this thesis, as I have chosen to focus specifically on independent innovators within this sector. Another interesting finding of Sandströms was that the importance of independent innovators had increased over the last 30 years (Sandström 2014: 12). This inspired a question about changes over time in the prevalence of independent innovators in the selection chosen for this thesis.

To study the empirical prevalence of a specific type of innovation agent, examples of innovation are needed. For the material for this thesis I have chosen to use the SWINNO database (K. Sjöö, J. Taalbi, A. Kander and J. Ljungberg 2014: 6). This is a newly constructed database containing a large number of Swedish innovation cases collected from trade journals, using the literature based innovation output method by which cases of innovation has been determined on the basis of article texts. It was constructed primarily by Karoline Sjöö and Josef Taalbi at Lunds University, and contains cases from the 1970s up until 2007. The innovations have been organized according to the economic sector they

belong to, using the system of SNI codes. In this thesis, a subset of innovations from the ICT sector will be examined and classified for the purpose of understanding how many were developed by independent innovators. As the records consist of journal articles they should have a degree of depth of information that makes it suitable for this kind of classification. Since the records span many years they also allow for comparison over time, as I have chosen to classify records from the entire period. After reviewing this background, the aim of the thesis will now be stated.

2.1 Aim and Research Questions

The aim of this thesis is to investigate how common the independent innovator is as a source of innovation. This will be answered by classifying cases found in the SWINNO-database of innovations according to the organizational status of the inventor, in an attempt to capture instances of independent innovators. The classification will be done using categories inspired by the aforementioned scheme of Frankelius and Norrman. This aim is captured by the following research question:

RQ1: How many innovations were developed by an actor that can be classified as an independent innovator?

Based on the discussion of Frankelius and Norrmark, I would like to classify independent innovators more closely in order to gain greater clarity of the organizational contexts of independents. This aim prompts the second research question:

RQ2: Out of the independent innovators, how many are inventor-entrepreneurs[1] and how many are inventor-inventors?

Another aim, prompted by the findings of Sandström, is to determine whether the importance of the independent innovators have increased over the last 30 years. This will be answered by analyzing the results of the classification. This aim is captured by a third research question:

RQ3: Does the number of independent innovators increase over time?

The questions will both be answered by using the aforementioned selection of ICT-sector innovations records.

[1] I use the this term for the entrepreneurial inventors identified by Frankelius and Norrman, and that was described on page 5.

3. Theory

As the Oxford Handbook of Innovation puts it; innovation is invention carried out into practice by commercialization (Fagerberg 2005: 5ff). However, both invention and innovation are continuous processes, meaning that defining the "invention" or the "innovation" entails a subjective selection of a specific moment in the development (Fagerberg 2005: 5ff). This definition can be specifically difficult to make as innovations tend to consist, in fact, of a multitude of other innovations with their own development timelines. An innovation can be tangible, like a product, or intangible, like a process method or an organizational scheme (Frankelius & Norrman 2013: 36ff). For example, there are also innovations in the service sector, such as financial instruments.

This thesis poses questions about the origins of innovation, and attempts to answer these by focusing on the actors behind innovation. This essentially means that the actor, or the agent, is seen as the *innovation determinant*, meaning the key ingredient without which innovation would not occur. However, the agent is not the only possible variable one could place as the determinant. John Sundbo explores this theme in his "Theory of Innovation".

Sundbo introduces his book by defining his research question: "How does the innovation process take place in society today, and what theories are available for understanding and explaining the innovation process?" (Sundbo 1998: 1). He is essentially interested in the history of innovation theories and their development. Based on the idea that innovation research is a diverse subject, he wishes to identify "one or more coherent explanations of how innovations arise in society" (Sundbo 1998: 8). He structures his inquiry by organizing theories into different paradigms - paradigms being defined as "a particular basic theory that has prevailed by becoming the normal perception". Sundbo means that during different times in history different paradigms has ruled in the area of innovation research and that separate paradigms of theories offers different solutions to the question of how and why innovation occurs (Sundbo 1998: 47,60,85).

These paradigms are: the entrepreneur paradigm which emphasize psychological factors and the individual entrepreneur as the determining factor; the technology-economics paradigm which promotes technology and technological development as the crucial element; and the strategic paradigm which points to sociological explanations and the strategic planning as the driver of innovation. Below I will further outline these.

The technology-economics paradigm is according to Sundbo connected to the growth of companies into bigger organizations and the maturity of the market, which meant that products had to become more complicated (Sundbo 1998: 60). Rather than the sporadic, impulsive innovation of single entrepreneurs this paradigm represents a more systematic, scientific approach to the process. Internalized in big R&D-departments, the development of new technology is seen as the core of innovation activity. The agent in this case in the professionally trained skilled technician, not the driven entrepreneur. Technology development is however seen as happening within a complex economic and social system that removes the emphasis on the individual effort that we find in the entrepreneur paradigm's explanations. The technology-economics paradigm came to be as a result of the increased theoretical importance given to technology as a factor of change on the fields of sociology and economics in the early decades of the 20th century (even though the importance of the technology-economics paradigm only fully matured during the 80s). Sundbo mentions here the works of William F. Ogburn in sociology. Ogburn stated that the material culture, that is technology, determines the boundaries for what he called the adaptive culture, our behavior. Since technology in that sense is the "envelope" of human interaction it is also a crucial determinant of the societal and economic development. In the field of economics, the importance of technology was long disregarded as the mainstream neoclassic theory did not have any tools for incorporating this factor into its models. The existence of seemingly inexplicable growth thus drove economists to inquire about possible solutions, out of which technology was one. Solow is usually credited for theoretically "discovering" the importance of technology by assigning it as a the residual factor chiefly responsible for the unexplained growth.

The innovation determinant in the strategic paradigm is less tangible but nevertheless distinct enough to qualify as a separate solution (Sundbo 1998: 85): this paradigm considers the determinant to be "the ability to analyze the market and the social surroundings as a whole; to shape the results of the analysis into an operationalizable plan, idea or action; and to use this to develop the company's overall organization so that the company makes better products in a better way, markets them better and meets people's needs in a better way." It is the very act of strategic planning that is considered to be determining, and with this the professional manager becomes the prime agent. Even though it is not clear that this tradition has completely disregarded technology as a determining factor, this line of thought is different because it views the resources of the firm as broader than the qualities of the R&D-department. Sundbo

describes theories from the discipline of business economics, for example Hamel and Prahalad's idea of the firms "core competence" as being not its products but its ability to develop new products. Organizational structure and "corporate climate" becomes important hereby. Another important point to make is that this tradition naturally stresses the pull-factors of innovation more than the traditionally more push-oriented entrepreneur and technology-economics.

These two paradigms, while different from each other, shares more common characteristics than the third paradigm, the entrepreneur paradigm (Sundbo 1998: 47). They both focus on the company or organization level and have a more top-down logic in terms of where initiatives for innovation originates. They also have a more rational view of the innovations process compared to the haphazard, processual nature of the actions of the entrepreneur. Also, the solutions in the two first paradigms are sought outside the psyche of individuals. This separates the entrepreneur solution clearly and it is this contrast that makes Sundbo's work relevant to this thesis. His suggestion of paradigms prove that focusing on the actor is but one way to answer the question of how innovation comes about. Having thusly clarified the angle of this inquiry, I will now describe innovation and the innovator in economic theory.

The innovator as a economic actor was described in economic theory by the father of innovation hype himself; Josef Schumpeter. He introduced in his "Theory of Economic Development" the striving entrepreneur as the primary agent of economic change (Schumpeter 1934/1983: 74). In responding to changes in the structure of the economy, he later qualified his description of the origins of innovation by admitting that the R&D-departments of large, incumbent firms may have become as relevant as the independent entrepreneur (Granstrand & Ålänge 1995:133ff). These separate explanations from the theorist are known as Schumpeter Mark 1 and Mark 2.

Schumpeter has been credited with reintroducing the entrepreneur and innovation into the framework of economic theory, after they had largely disappeared under the rule of neoclassical economics during the 19th century (Courvisanos & Mackenzie 2014: 14,22). In neoclassical theory, emphasizes lies on equilibrium and static rules upon which rational, calculable decisions are made, and this framework did not have the tools for analyzing innovation as a phenomena. Schumpeter described the neoclassical economy as the circular economy, which operates after the same functions all the time and in which only extensive growth is possible. Thus, he likened it functionally to a blood flow which can increase or

decrease in volume, in response to for example external shocks like wars, but that always follow the same lines (Schumpeter 1934/1983: 5). It keeps functioning in the same patterns, according to the same framework of channels. Schumpeter then argued that there were other changes that completely altered the existing economic patterns, and altered the rules (Schumpeter 1934/1983: 61). These changes came from within the economy itself. How did this other kind of qualitatively different growth occur? Schumpeter did not believe that capital was to be viewed as a factor in production; he instead saw the entrepreneur as the third production factor next to land and labor. The entrepreneur thus spurred growth from within in the system by achieving "new combinations": innovations (Schumpeter 1934/1983:66). These new combinations tossed the economy into disequilibrium through the process of creative destruction, by which old industries, assets and knowledge decreased in value as a result of the introduction of the new combination (the innovation) that utilized production factors differently. This way, new economic laws were established and the economy was changed.

Schumpeter had a rather broad definition of his "new combination"-concept, meaning that it is somewhat more extensive then what is usually understood as "innovation" today. He included 1) the introduction of a new good, 2) the introduction of a new production process, 3) the opening up of a new market, 4) the opening up of a new source of raw material or half-manufactured goods and 5) the carrying out of a new organizational structure (Schumpeter 1934/1983:66).

The agents who accomplish these new combinations, the entrepreneurs, are the "frontrunners of the pack" who boldly go where none has gone before, inspiring others to follow suit. Schumpeter emphasizes two perhaps contradicting views on the nature of the entrepreneur (Oakly 1990: 110f). On the one hand, he clarifies that a person is only an entrepreneur while carrying out any of the above mentioned new combinations. The function therefore seems temporary, and appears to be a role. On the other hand, Schumpeter argues that the entrepreneur is a special kind of person, endowed with special physiological characteristics. This makes the function seem more predetermined and in nature more similar to a personality. Below I will discuss the complexity in defining the actors in innovation empirically.

3.1 Inventor, innovator, entrepreneur

Since the aim of the thesis is to identify instances of independent innovation, a focus on the circumstances of the agent responsible is prompted. Only, as was stated earlier, the complex nature of innovation means that there are many possible aspects to focus on and that there is

no exactly definable stage at which innovation "happens". In turn, this means that there may be a number of actors who have contributed by performing different functions in the over all process. So, who is to be considered the agent in the process, and therefore researched? Schumpeter spoke of *the entrepreneur* as the one who carries out the new combination. Frankelius and Norrman define *the innovator* as a person who "drives innovation". However, these rather abstract definitions does not provide sufficient guidance as to which actor should be considered in the empirical examples I intend to examine.

To better answer this question, we look to the activities that constitute the innovation process: innovation is invention carried out into practice through commercialization (Fagerberg 2005: 5ff). By describing these activities, we can hopefully identify more clearly the actors involved. First, what is invention? Inventions are often defined as being some sort of technical apparatus that fulfills a purpose more efficiently, or simply as a technical feature with news value (Frankelius & Norrman 2013: 30f) . However, it does not have to be a physical "thing" but can also be a new idea on how to organize business, or other intangible services. The person who comes up with inventions is *the inventor*. But the invention is not an innovation, yet. Another step is needed. This is where the function of *the innovator* becomes relevant, as the person who pushes to turn the invention into an innovation by commercialization. However, this is a rather wide definition, and the innovator is not a simply a business leader. Schumpeter called him an entrepreneur, but pointed out that indeed most business managers are not innovators, as they manage using routine decisions according to known rules within the circular economy (Oakly 1990: 112f). The entrepreneur acts to break these known rules by introducing new combinations and therefore operates in true insecurity. Also, the entrepreneur is in Schumpeterian logic only that while performing the activity of introducing new combinations. Being an entrepreneur is hence a temporary function, not a profession, and business leadership broadly cannot be equated with conducting innovation. In fact, whilst they are spoken of as actors inventor, entrepreneur and innovator are all descriptions of functions. Hence, in some cases, they may also be the same person.

Who are the people fulfilling these functions? The innovator and the inventor as economic actors, if we concentrate on those who would also be considered as independents, may be exemplified by the stories of our most well-known and heroic inventor-entrepreneurs like Tomas Alva Edison, who created and ran firms that grew into empires to exploit their inventions (Hintz 2007: 7). However, this is but one type of actor that can be classified as an independent innovator and therefore be of interest for this inquiry, as is also clear from the

Frankelius and Norrman scheme. Another type is the independent inventor who does not start a firm to profit from his inventions, but rather sells his inventions or license them to firms or other individuals.

With this discussion we have seen the difficulties in defining and therefore classifying the agent behind innovation. A method for this was needed to enable this inquiry to be clear and concise. Hence, I have decided to focus on *the invention and the inventor* as the source of innovation. Only when the inventor has invented as an independent individual *and* then commercialized the invention either through starting their own firm and thus engaging in entrepreneurship, or by licensing or selling it, have I classified it as a case of independent innovation. With this focus, I have not classified the circumstances of those who are pure entrepreneurs; those who may commercialize inventions developed by employees. To chose the inventor over the entrepreneur is a but one choice of perspective on how to examine innovation. One could easily have come to the conclusion that the more important ingredient is the contribution the entrepreneur makes, and hence the circumstance of the entrepreneur should be analyzed. This balance act is the result of the processual nature of innovation. It is a question of "where to draw the line" on when innovation happens. Entrepreneurs who simply brings to market an already developed product can surely be considered innovators. However, an entrepreneur can be hired by a large firm in order to commercialize something developed in a huge R&D-lab in a newly set up corporate spinoff. I believe that this is further from the lone innovator narrative that thesis was inspired by, than what will be the result of an inquiry which searches for innovation developed *and* commercialized by independent individuals. This is why I have chosen to let the inventor be the focus of my investigation.

4. Previous research

4.1 Challenging the historical disappearance of the independent inventor

When examining a phenomena it is vital to ask what is already known about it. When it comes to independent innovators, the traditional narrative is that they were a major source of innovation during the 19th century, but that they could no longer compete in the 20th century, as technology became more expensive and larger corporations with their own R&D-departments too stiff a competition. Some researchers push to question this story and ask whether the downfall of the independents has in fact been exaggerated in scope and scale. Naomi R. Lamoreux and Kenneth L. Sokoloff challenges the story of the early superiority of in-house development by claiming that the difficulties associated with contracting technology

from the open market during the first decades of 20th century have been overstated (Lamoreux & Sokoloff 1997: 4). They argue their case by examining sales of patents in the US from the late 1800s. They say that while it has traditionally been supposed that difficulties concerning imperfect information made contracting technology from outside the company difficult and unreliable, and therefore expensive, actually the patent records show that a substantial volume of this kind of trade occurred (Lamoreux & Sokoloff 1997: 49). Also, the authors argue that the difficulties facing firms in this era looking to put internal research and development to more use may have been understated. Specifically, before contracts requiring employees to turn over inventions created during work time became standard, "trust issues" between inventive employees and management were a frequent source of missed opportunities for the firms (Lamoreux & Sokoloff 1997:50).

Another author, Eric S. Hintz, also argues that the continued influence of the independent innovators have been underestimated (Hintz 2007: 12). He questions the narrative about how the corporate R&D department effectively crowded out the lone inventor already in the beginning of the 20th century, claiming that this actor actually remained relevant for a much longer time period. To prove his contention he cites US patent statistics for the last century, reveling that corporations did not outnumber individuals as patentees until the 1930s (Hintz 2007: 2). Even then the independent inventor did not become a purely historical figure. Still in the 1950s they stood for around half of all patents filed. How did they survive alongside the giants? Hintz means that one way this could have been possible was through the kind of close, extensive collaboration between a company leader and an outside inventor as is exemplified in the story of independent inventor Samuel Ruben and the P. R. Mallory Company (Hintz 2007: 3). The partnership spanned several decades and a number of innovations. Ruben remained an independent during the entire duration and the venture was highly successful to both parties. And he was not the only one. According to Hintz, this collaboration with talent from the outside was a signature move of the leader of the Mallory Company, Philip Rogers Mallory (Hintz 2007: 5). Mallory indeed specified that working with the independents was an integral part of the firms innovation strategy, and there are dozens of examples of this in the firms history. Interestingly, Mallory simultaneously invested heavily into the firms internal research laboratories, causing Hintz to describe his innovation strategy as "mixed". Finally, Hintz means that this more complex mixed model of innovation is not captured accurately by existing theoretical frameworks which tends to portray either the inventor-entrepreneur, like Edison, the inventor who routinely sells his patents to the highest bidder and the large firm

R&D-labs that replaced them both. He means that the collaboration between Ruben and Mallory represents a type of relationship between economic actors not covered by these options.

4.2 Independent innovators in the economy

If, as this research argues, the independent innovators have been underestimated, is there any measure of how much they contribute to overall innovation activity?

Christian Sandström examined, in a paper from 2014 mentioned earlier in the thesis, the organizational origin of 100 of Sweden's most important innovations. In differing between independent inventor/entrepreneur, employees at larger firms and employees at universities and research institutes he found that 47 % on the innovation were developed by employees of larger firms, and 33 % by independent inventor/entrepreneur (Sandström 2014: 7). The smallest share, 20 %, of the innovations were developed by university employees. However he found that the differences are vast between different sectors. Even though the universities were the least common innovator in total, in the medical sector they were responsible for more than half of the innovations in the selection. Simultaneously, the independent innovators were very uncommon in the medical sector whilst they created almost half of all innovations in the IT and telecom sector. Another finding, as has been mentioned, was that the importance of the independents had increased over the last thirty years (Sandström 2014: 12).

In a earlier study of Swedish innovations by O. Granstrand and S. Alänge, the origins of a certain selection of especially important cases were examined similarly. The authors aim to analyze the significance of corporate entrepreneurship, that is Mark 2 type of innovation, in Swedish economic activity (Granstrand & Ålänge 1995:136). This analysis is carried out on a innovations database created at Chalmers University, containing 100 cases of "major civilian innovations" ranging in time from 1945-1980 (Granstrand & Ålänge 1995: 138). These one hundred innovations are argued to have been significant in both an economic and a technological sense. In their inquiry the authors also analyze the interplay between different kinds of innovation actors. Ultimately Granstrand and Alänge whishes to establish the pattern of Swedish innovation in order to compare it to Schumpeters "development theory" (Granstrand & Ålänge 1995:133ff). They explain that according to this Mark 1 and 2 innovation patterns are not to be regarded as competing alternatives, but rather as parts in a succession. When the large firms had overtaken the independent innovators, the next step Schumpeter proposed was for the state to take a larger role in the creation of innovations. This

theory was another example of Schumpeter adjusting to changes in the economy, with the growth of state socialism over the 1900s. Upon examining the innovation records, the authors found that private large corporations were responsible for 76.5 % of the innovations, and they were the dominant innovators in almost all sectors (Granstrand & Ålänge 1995:153ff). However, over the time period examined, that dominance declined. Autonomous or independent entrepreneurship was found to be behind 20 % of the innovation. Their share had instead increased somewhat over the period studied. It also became clear that the prevalence of independent innovators varies significantly between different sectors. For example, they were even more prevalent than the private large corporation in the fabricated metals industry, but were completely nonexistent in the medical drugs sector. This mirrors findings from Sandström.

Granstrand and Alänge results did not support the developmental theory of innovation as argued by Schumpeter (Granstrand & Ålänge 1995:151). They did not find that the independent innovator had become irrelevant, and they definitely did not find that the state had succeeded corporations as the primary agents behind innovation. The state through state owned companies had a marginal influence over the period, with only 3,5 % of the innovations in the selection. However, in 18 % of all innovation cases was a university the "idea source", and in this way the state had a more important indirect influence.

The authors also analyzed interplay between different kinds of innovators. There was substantial such interplay between the independent entrepreneurs and the large corporations (Granstrand & Ålänge 1995:154). Granstrand and Alänge find for example that the larger firms may be a important providers of experience for the independent innovators. In the sample, a large firm had been an important source of training for 50 % of all the identified independents. A common story seems to have been that a person discovered something while still working as an employee for a larger firm, that was not a fit with the firms ordinary product portfolio. Therefore the idea was spun off into a new company. Granstrand and Alänge also argued that these independent entrepreneur firms often are acquired by larger firms later, and this way technology and experience is also transferred back into the big firms. The authors argue that this accounts show how independent innovators are influenced by and can benefit from the large player in an industry. This realization, they mean, is important to counteract stories of entrepreneurs who emphasize exclusively the personal effort and the capability of the person involved. The authors thus conclude that a dynamic perspective on the patterns of innovation is the most beneficial.

The above mentioned statistics concerns Sweden. For an international outlook, we can turn to Brian Spears investigation of British independent innovators. He examines patents that have been renewed for the full possible term of twenty years (Spear 2006: 142). This is to find the most valuable patents to analyze, following the logic that patents that are defended in spite of increasingly expensive renewal fees must be valuable to their owners. He analyzed samples of this kind of patents expiring in 1970 and 2003 (which were subsequently filed by independents around 1953 and 1983). Spears found that the independents were responsible for about 30 % of patents in both samples (Granstrand & Ålänge 1995: 143). He remarks especially that the independents kept their share over time despite a dwindling number of patents of British origin over all. This proves independents are and have been important contributors to innovation also in Britain.

4.3 Characteristics of independent innovators

Who are the independent innovators? Researchers Cynthia Wagner Weick and Cynthia F. Eakin attempted to address some of the knowledge gaps on independents with a survey. By utilizing the mail lists of the United Inventors Association and the Inventors digest, two organizations that work with independent inventors, they reached a number of 351 independents (Weick & Eakin 2005: 8). Most were part-time inventors, but 17 % devoted all their time to their passion as full-time inventors. The inventors differed greatly in the number of years in which they had by their own account been inventing. Some for just a year, whilst others for several decades. In fact, 41 % said they had been inventing for more than ten years.

Weick and Eakin also found that an overwhelming majority (82 %) were male and their mean age was 50,1 years (Weick & Eakin 2005: 8). These characteristics are similar to those found by Amesse who surveyed 1023 independent Canadian inventors (Amesse et al 1990: 16f). He found the median age to be 46 and an even more overwhelming male majority of 98 %. Thomas Åstebro also sampled Canadian inventors, who had sought help from The Inventor's Assistance Program provided by the Canadian Industrial Innovation center. In his study, the number of male inventors represented 89 % of 1095 respondents (Åstebro 1998: 43). The findings that the average inventor is a middle aged man seems to be representative on the independent innovator literature overall (Amesse et al 1990: 17, Weick & Eakin 2005: 12). It also seems that the situation is comparably unequal in Sweden, as female patentees only accounted for 6 % of all patent applications in 2015 (PRV 2016).

As for the educational attainment level of independent inventors, Weick and Eakin found that over 50 % possessed at least an undergraduate degree (Weick & Eakin 2005: 8). In Amesse's selection, he found that 58 % had completed postsecondary studies, and 43 % held a university degree (Amesse et al 1990: 17). Engineering and applied sciences were common degrees. According to a study on Swedish inventors by Ejermo, not just independents, but all inventors have a high educational attainment, as more than 80 % have secondary education and more than 20 % had postgraduate education (Ejermo 2011: 1). Amesse also found that 46 % of the inventors in his sample were self--employed entrepreneurs (Amesse et al 1990: 17). If they were employees they were most likely to be professionals, skilled workers or administrators and managers.

4.4 Innovation processes of independent innovators

The above mentioned study by Weick and Eakin inquired not only about inventor characteristics, but also about their inventive habits (Weick & Eakin 2005: 8f). They were asked to disclose how many working prototypes they had developed over the past five years; the most common answer given was one. 52 % of the inventors patented at least one invention developed in the last five years, while a little over 40 % held no patents at all. Of inventions developed over the past five year, 73 % of the inventors had attempted to commercialize at least one (Weick & Eakin 2005: 8f). 39 % had generated sales with an invention and 22 % had generated profit. As for the mode of commercialization, 55 % of inventors had tried bringing the invention to market through a start-up firm, 44 % through licensing and 16 % sold their inventions outright. In his inquiry, Amesse found that the average Canadian inventor had created 6.5 inventions (Amesse et al 1990: 17f). 47.5 % held between two and ten patents while 55,2 % held but one patent, and smaller number over ten patents. Most inventors therefore seemed to rather be occasional than professional inventors. In his selection 43 % of inventions were commercialized (Amesse et al 1990: 20f). The absolutely most common way to commercialize was through entrepreneurship, either by commercializing the invention in a company the inventor already ran, or by starting a new firm. Only ten percent of commercialized inventions were taken to the market by licensing or sale of rights. Åstebro found a much lower likelihood of commercialization amongst the independent inventors he surveyed (Åstebro 1998: 43); only 6,5 % of the inventions in the selection were commercialized. However, it has been pointed out, that his data comes from a program meant to assist inventors. Therefore, it hypothesized that the inventors in his inquiry are inventors who experienced issues with their invention (Weick & Eakin 2005: 13). These

inventions may thus have a lower likelihood of commercialization than the average invention. Also, his inquiry does not cover licensing.

Amesse inquiry found that most independent inventors, 77 %, develop new products or improvements for existing products (Amesse et al 1990: 18). A smaller number develop process inventions. Wagner and Eakin, in their inquiry, asked inventors which sectors they invented within (Weick & Eakin 2005: 8). The most common were hardware and tools, household and industrial/commercial. The least common sectors for the independents to get into were marine/ocean technology, telecommunications and the biological/microbiological sector.

Amesse finds that the average development time of an invention up until a patenting application occurs, although the results vary a lot, was 22 months (1,8 years) (Amesse et al 1990: 18). However, 60 % of the inventors continued to develop their inventions for on average another 21 months after the patent application moment. He also found that 61 % of the inventor-entrepreneurs in his inquiry proceeded to commercialize their invention within the same year as the patent application occurred. Åstebro instead measures the average development time spent by independent inventors up either until the moment of commercialization, or until the inventor stops developing the invention (Åstebro 1998: 43). He found that the average development time for the inventions that reach commercialization was two years, and that the unsuccessful inventions were developed for an average of 0.6 years.

4.5 The value of innovations from independents

According to Åstebro, the survival rate of innovation-based start-ups seems to correlate with the survival rate of start-ups in general (Åstebro 1998: 44). Åstebro thus concludes that innovation is not riskier than entrepreneurship in general. Åstebro also found that once on the market, innovations from independents achieve profit margins at par with those of established firms (Åstebro 1998: 44f). These margins are due to the low developmental costs of independent innovators. He hypothesizes that this is either because independents are usually financially restrained and therefore does not have the opportunity to spend a lot or that most independents develop inventions of relatively low technical complexity.

It seems as if the way in which the innovator brings his invention to market affects the value of independent innovation. Weick and Eakin found in their study some differences in the

economic value of independents inventions on account of their mode of commercialization (Weick & Eakin 2005: 8). According to their inquiry, the start-up firm is the surest way to achieve sales. However, they also find that licensing is correlated with higher levels of sales. Amesse also found that those commercialize through entrepreneurship were more likely to achieve profits (Amesse et al 1990: 20). But not only was entrepreneurship a better option than licensing or sale as a method of commercialization; those inventors who already were self-employed had a greater likelihood for commercializing their inventions and they achieved more profits than those who were employed (Amesse et al 1990: 21). This points to the importance of entrepreneurial spirit and experience for independent inventors, says the author.

In another study Kristina Dahlin, Margaret Taylor and Mark Fichman also tries to answer this question of the varying value of independents' innovations by examining the US tennis racket industry (Dahlin, Taylor & Fichman 2004: 2ff). The wanted to find out, in their words, whether independent inventors in this sector should most appropriately be described as "today's Edisons" or "weekend hobbyists". According to a set of criteria concerning technical merit and commercial success they attempt to establish how patents from corporate inventors differ from independents (Dahlin, Taylor & Fichman 2004: 4). Technical merit is judged by three dimensions. The first is the impact of the invention, which is measured by the number of subsequent patent citations. The second is level of detail. This was determined by carefully examining the claims section of the patents that outline the content of an invention. The third dimension is scope; whether the patent covers the whole racket or a separate part of it, and whether it was a patent concering product or process. This was also determined by using the claims section of the patents. The other aspect in judging the value of patents by independent and corporate innovators was the commercial success. This was research by analyzing the level to which the patent renewal fees were paid. These optional "updates" of the patent is thought to provide an indication of how economically valuable the patent is to its owner.

On the question of impact of the patent, independent inventors were hypothesized to have patents with either very high or very low impact (Dahlin, Taylor & Fichman 2004: 6). This was based on the idea that industry outsiders have a greater both explicit and subconscious freedom to experiment than firm employees as they not entrenched in the usual way of doing things, which is why the can create truly radical inventions; but also that they at the same time have less access to top level technological knowledge and may thus create less relevant inventions. The results did reveal that indeed independent inventors often held especially high- *and* low-impact patents (Dahlin, Taylor & Fichman 2004: 16). In other words, they

were disproportionally found in the tails of the distribution impact-wise. For the level of detail, it was hypothesized that corporate inventors' access to in-house resources and technical knowledge would mean that their patents display a higher level of detail (Dahlin, Taylor & Fichman 2004: 7). This was also found to be supported (Dahlin, Taylor & Fichman 2004: 17). The authors further expected independents to hold patent of less scope than corporate inventors following the logic that they would consider a specific problem rather than update the whole product; this was not unambiguously supported as independents patent often concerned the whole racket (Dahlin, Taylor & Fichman 2004: 8,19). On the question of commercial success, the authors hypothesized that independent inventors would have less commercial success than their corporate counterparts (Dahlin, Taylor & Fichman 2004: 4). Using their method of counting patent updates, they found no significant difference between the two kinds of inventors (Dahlin, Taylor & Fichman 2004: 8,19). Overall the authors concluded that their research had found that independent inventors in this sectors are a very heterogeneous group and that evidence supporting both the "Edisons of today" and "weekend hobbyist" narrative.

In a paper following up on the research by Dahlin, Taylor and Fichman another set of researchers tried to answer the question of why independents are such a diverse lot and what determines some the discovered differences. Christopher Lettl, Katja Rost and Iwan von Wartburg examined independent inventors in the medical equipment industry (Lettl, Rost &Wartburg 2007: 243). Their interest is the technical significance of inventions from independents, as they say this aspect has been less studied. They authors motivate their research interest by stating that unlike market success, which can be fleeting, a contribution to technical progress is forever. In attempting to answer this question, the authors assume that the impact of a specific inventors invention is a product of the body of pre-existing knowledge put in to that invention (Lettl, Rost &Wartburg 2007: 243ff). So, if a inventor has access to a larger body of knowledge the invention is bound to have a larger impact. This body is measured in two dimensions. The first is the depth of knowledge an inventor has access to; the degree of specialization. The second is the breadth of knowledge; the diversity of the knowledge. On diversity the authors mentions that two conclusions have traditionally been drawn about the concept. Diversity of knowledge increase the likelihood of finding new perspectives and being innovative by putting together information from a broad range of field. However, on the flip side, diversity risks causing information overload with entailing confusion and low productivity. Holding these conclusions in mind the authors hypothesize

that diversity will have a negative effect independent inventors, as he or she has only limited resources for collecting, organizing and processing diverse information (Lettl, Rost &Wartburg 2007: 246). But, a corporate inventor with an organization behind them have coworkers, libraries, administrative systems and other resources that mean they are in a much better position to effectively handle large amounts of diverse knowledge and can therefore unlock its benefits. Diversity will thusly have a positive effect on corporate inventors. As for specialization the authors mention that it is thought that a certain level of sophistication is needed to create something truly impactful. This is why most inventors of significance have as much as a decade of experience in their particular field. Specialization is thought benefit both independent and corporate inventors, but to a different degree. For independents, it makes up for not having access to the kind of accumulated knowledge that is embedded in a firm. Furthermore, specialization increases the likelihood of the independent inventor being associated with a peer network for individuals interested in the same thing. It takes a certain level of specialization to reach these networks; but once on e is a member these organizations also serve to further educate. Also, a peer network can substitute many of the functions that are inherent for corporate inventors, like having a group of qualified individuals to test your ideas on. This communication is thought an important step to increase the quality of independents inventions. In view of these arguments, the authors hypothesize that specialization will have larger positive effect for independent than for corporate inventors.

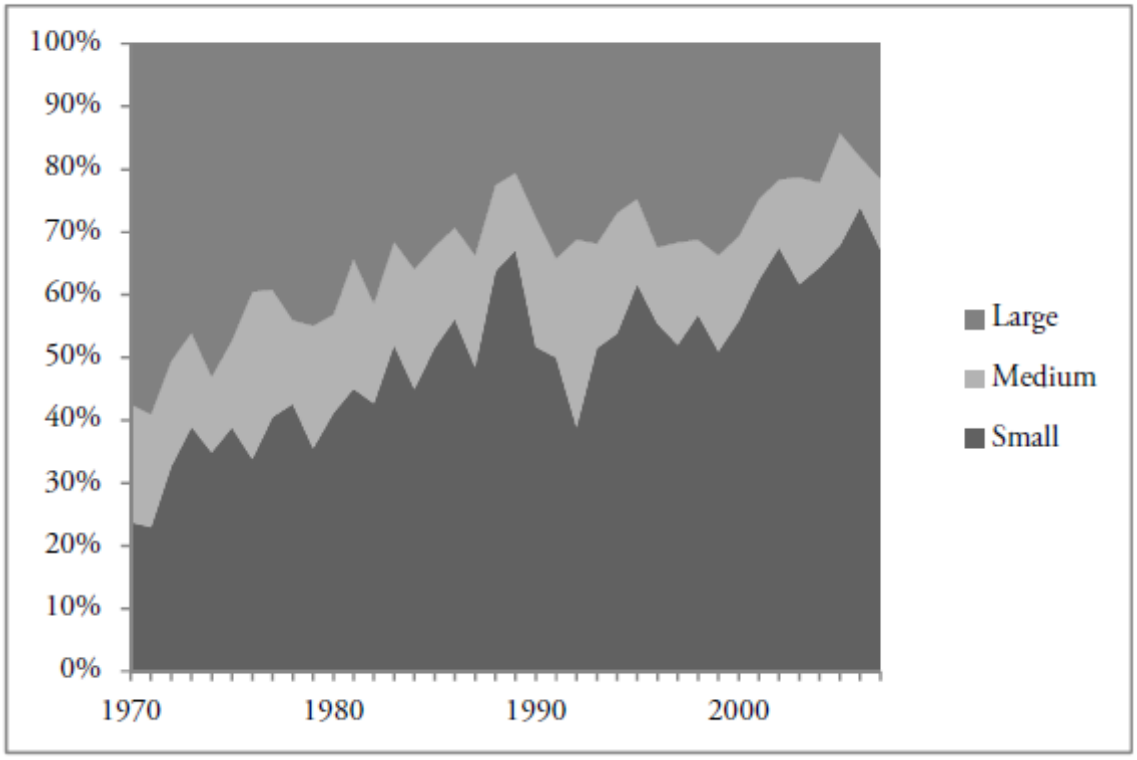
Inspired by Dahlin et. al., the authors answer the question of how diversity and specialization affects the level of impact of an invention by using patents (Lettl, Rost &Wartburg 2007: 246). The number of subsequent patents citing the invention is used to measure the technical impact. The diversity of knowledge is measured by how many different fields of technology the citations of the patent reference, and the degree of specialization by the number of citations. They found that in the examined industry inventions from independent inventors have a lower impact overall (Lettl, Rost &Wartburg 2007: 248). They also found that independents apply a greater deal of diversity than corporate ones, and that indeed diversity has a larger negative impact on inventions by independents than on those by corporate inventors. Their research also found that specialization was important to achieve impact for independents. The results also supported that specialization has a much greater positive effect on impact for independents than for corporate inventors. The authors believe that too low specialization with too high diversity is what makes some independent inventors "hobbyists"

of little impact, and that high specialization with less diversification is what makes the independent inventor successful.

4.6 The agents behind innovation in the SWINNO-database

In her doctoral thesis, Karolin Sjöö investigates the innovators in the SWINNO-database. She finds significant evidence of Mark 1 innovation activity in SWINNO, in that small firm innovation (defining small as below 50 employees) has increased consistently throughout the period studied (Sjöö 2014: 193).

Figure 6.1 Distribution of innovations across firm-size classes, 1970-2007 (percent)



Source: Sjöö 2014: 193

Another finding was that the share of innovations by start-up firms had increased, especially since 1990's (Sjöö 2014: 196). A specific kind of start-up recorded in the SWINNO-database is the academic spin off; a firm a started to commercialize results of research. While these have also increased, they do not drive the total increase on start-up innovation as they make up for only a quarter of all start-ups between 1990 and 2000, and between 2000 and 2007. As Sjöö puts it, "diligent academic entrepreneurship" is thus not the whole explanation (Sjöö 2014: 199).

Furthermore, Sjöö finds that small firms created more novel innovations, compared to medium and large sized firms (Sjöö 2014: 206). They also created the most innovations that were new to the entire world market. This supports theories that small firms are more likely to invent radical innovations, due to greater mental and organizational flexibility (Sjöö 2014: 36). Sjöö also comments that this contradicts the emphasis on large firms in Swedish domestic innovation literature (Sjöö 2014: 220).

4.7 The telecommunications sector in the SWINNO-database

Telecommunications, as a part of the ICT-sector, experienced a boom in innovation after the 1990's crisis (Taalbi 2014:117). After the breakthrough of microelectronics, as electronic components became cheaper, the market for ICT products grew immensely. Josef Taalbi writes on this sector that innovation efforts were largely focused on "enabling increased transmission capacity of telecommunication networks as it were, resolving bottlenecks that have arisen as the traffic volumes increased" (Taalbi 2014:117). The sector was also fueled by the introduction of Internet. The Swedish telecommunications sectors was long dominated by state owned Televerket and the Ericsson concern. Televerket as an actor was more prominent before the event of substantial deregulation of telecom markets, but Ericsson has remained an important innovation contributor throughout the period covered in SWINNO (1970-2007). Indeed, Ejermo concludes that Ericsson has contributed significantly to overall Swedish patenting (Ejermo 2011: 14). Around the time of the new millennium, the firm was world leading in mobile telephones. Following deregulation, many new firms entered the sector, but Ericsson remains an important innovator. By the growing importance of Internet, innovation in data communication equipment, network components and transmission systems incresed. Telia and, again, Ericsson were important players in these areas but a large number of innovations of this kind were the works of new entrant firms.

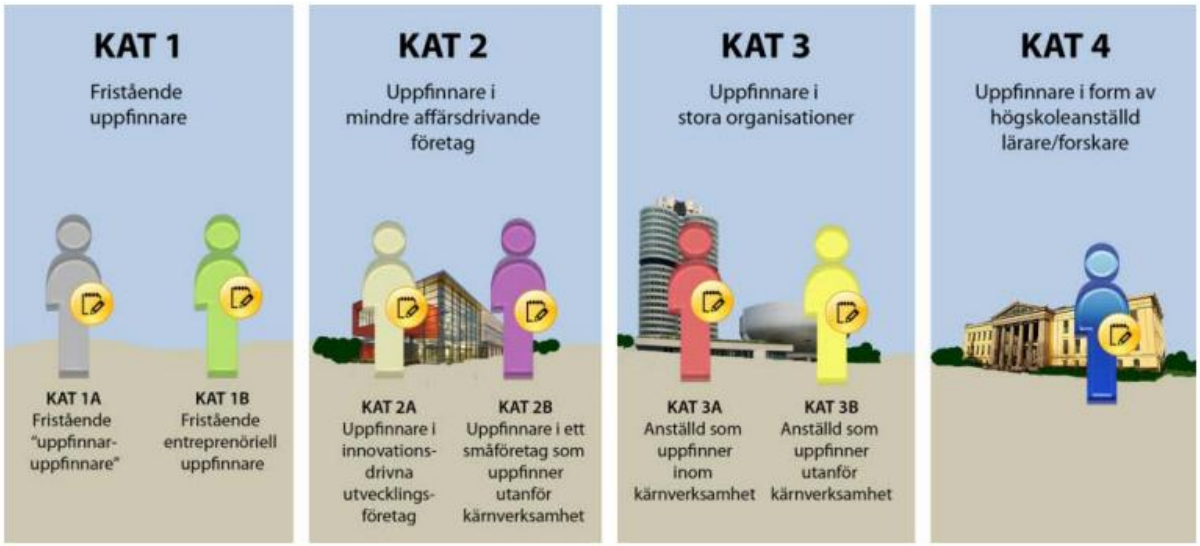
5. Material: the SWINNO database

As have been mentioned, the cases of innovation analyzed in this thesis was taken from the SWINNO database. The innovation database was constructed by Sjöö and Taalbi, and is modeled on a Finish predecessor named SFINNO (K. Sjöö, J. Taalbi, A. Kander and J. Ljungberg 2014: 2). The authors also both wrote their PhD-theses on the database (these works were cited above in chapters 4.6 and 4.7) and these were defended in 2014 (K. Sjöö, J. Taalbi, A. Kander and J. Ljungberg 2014: 1). SWINNO is focused on innovations in the manufacturing sector and contains more than 4000 records. The unique benefits of the database consists in the opportunities it offers to combine "depth and width" of information. As is described the "richness in detail combined with the large number of observations makes the new data suitable to both quantitative and qualitative analyses" (K. Sjöö, J. Taalbi, A. Kander and J. Ljungberg 2014: 2). The database was constructed using a object-based innovation output method called LBIO. This stands for *literature based innovation output method* and it entails that innovations are recorded by way of examining trade journal articles. Accordingly, a SWINNO innovation record consists of the record itself and the one or more article/s that is the source material on the innovation case. This method is an alternative to input focused innovation measuring methods, like looking at R&D investments or patents (K. Sjöö, J. Taalbi, A. Kander and J. Ljungberg 2014: 3). The idea is that output based methods will provide better information on actual innovation than the input measures, as neither R&D investment or patents can be considered exact proxies of this.

For a case of innovation to be recorded in the SWINNO database, several criteria had to be fulfilled: 1) the innovation had to be commercialized (or in the process of being commercialized); 2) the agent responsible for the innovation had to be discernible; 3) the innovation had to be a product innovation (defined as a product, process or service that was transacted on a market) and; 4) the novelty of the innovation had to be explicitly stated (K. Sjöö, J. Taalbi, A. Kander and J. Ljungberg 2014: 17). In order to increase the usefulness of the database the innovations has been sorted according to product group using the 2002 SNI coding system (Svensk Näringslivsindelning) (K. Sjöö, J. Taalbi, A. Kander and J. Ljungberg 2014: 22).

6. Methodology

Figur 6 Uppfinnarkategorier



Source: Frankelius & Norrman

For this thesis, I have been inspired by the categorization of inventors by Frankelius and Norrmark seen above.[2] The classification builds on the organizational circumstance of inventors. On this scale, the "inventor-inventor" reads as the most extreme example of independent innovation. But independent innovators can also be business owners and invent from this platform. Norrmark and Frankelius makes a point out of this distinction; "lone" or independent can be understood as concerning a multitude of aspects and it does not mean that the individual has to innovate alone. As such there is a spectra of "independentness" along which independents can exist. This thesis examines that spectra.

This thesis uses a quantitative method as its research aims are quantitative in nature. The inquiry have been operationalized by classifying the actors responsible for innovation in the selection for the SWINNO-database. The classification has been made based on the information found in the trade journal articles collected in SWINNO.

Remember, I am concerned with classifying organizational context of the *inventor*. The categories are as follows:

1. Employee - the inventor is inventing as an employee in a firm. This means that he invents within the core activities of the firm Perhaps, if he is in product development this simply

[2] The categories read: 1A: Independent "inventor-inventors", 1B: independent entrepreneurial inventor, 2A: inventors in innovation-driven development firms, 2B: inventors in small firms who invent outside of firms core activities, 3A: employee who invents within core activities of firm, 3B: employee who invent outside of core activities of firm, 4: employees of universities.

means doing his job. This distinction is important, as an independent inventor may very well also be employed; but he has not invented in the capacity of being an employee. This can for example mean that the innovation was developed in spare time. An employee may also have developed something at his job which he then leaves his job to commercialize. In this case the inventor is no longer seen as an employee, and is instead classified according to option 2. or 3. When a article has been classified according to this option; the text in the articles often read "the engineers at firm X have worked long and hard to develop...". The inventor has also been classified as an employee when the article simply states "firm X has developed..." as this is taken to imply that an employee is responsible for the innovation.

2. Inventor-entrepreneur - the inventor is commercializing his invention through a firm of his own. This may be a firm started specifically for this innovation, or the inventor may already lead a business, which he chooses to use for the commercialization of the innovation.

3. Inventor-Inventor - the inventor does not run a business based on his inventions and is thus not an entrepreneur. He may commercialize his invention through sale or licensing.

Alternative 2. and 3. are seen as instances of independent innovation, while alternative 1. is not.

The inventor is classified after the circumstance that was true during the particular innovation process in question. Hence, the same person may in one innovation process be classified as an inventor-inventor and in another as an inventor-entrepreneur. Therefore, this classification actually capture instances of independent innovation rather than independent innovators per se.

The results from the classification are analyzed to answer the research questions.

6.1 Limitations

Only a subset of the ICT-sector, telecommunications[3], will be analyzed. All records belonging to this sector have been analyzed. As a consequence, records for the entire period covered in SWINNO (1970-2007) have been covered.

[3] I have analyzed all innovation records with the product code SNI2002 32, telecommunications.

6.2 Concerns regarding the method

One concern is whether this inquiry adds to what already exists in the database. In SWINNO the *commercializing firm* is registered as the agent behind innovation. The lowest level recorded is therefore the firm level. An "inventor-inventor" would thus not be visible as an actor. Also, while there is a variable for start-up firm in SWINNO, a potential inventor-entrepreneur may already routinely operate from his own innovation development firm, in which case a new innovation would not also indicate start-up.

Another concern is that this method is sensitive to the level of detail in the articles, in order to make a classification. One can for example imagine that the articles which only describes that a firm has developed something, and does not disclose the innovations process at all, hide cases of independent innovation. However, all innovation measures have downsides. Patents are much used for purposes similar to this inquiry; but not all patented inventions are commercialized and not all innovations are patented. The SWINNO selection does not have this problem, since it only records actual commercialized innovations. Case studies are also common, since they give lots of colorful information. However, it would be desirable for the sake of quantitative ambitions to have more than anecdotal evidence. So, if patents and case studies are much used to research independent innovators and both have pros and cons, this method is the closest thing to a hybrid.

One further concern with the delimitation is that, due to industry specific structure, the findings from the chosen sector will not be generalizable to the economy as a whole.

7. Results

The selection of articles for this inquiry consisted originally of 287 innovation records. However, 4 were omitted for one of the following reasons: article does not discuss the innovation portrayed in the record; no article was connected to the record; the record is a double of another innovation in the selection. The total number of records analyzed was thus 283 (see Appendix, Table 1 for full results).

RQ1:

This inquiry found significant evidence of the activity of independent innovators, although the employed innovators were in majority. Independent innovators were responsible for 16 % of all innovations throughout the period studied, whilst employees of either firms or universities

and research institutes stood for the lion share of 84 %. *Thus, this inquiry concludes that innovation by independent innovators is significantly less common than employee innovation.*

RQ2:

The inventor-entrepreneurs made up for 12 % of all instances of independent innovation, and the inventor-inventors only 4 %. *Thus, the independent innovators in this sample for the most part chose the entrepreneurial route to commercialization.* However, there seems to have been a shift in the composition of independent innovators during the period studied. In 1970-1990 inventor-entrepreneurs accounted for 8 % and inventor-inventors for 7 % of all independent innovation. In the years 1990-2007 inventor-entrepreneurs were behind 14 % and inventor-inventors only 2 %. Thus, this inquiry suggests that it has become for common for independent innovators to be inventor-entrepreneurs.

RQ3:

In the period 1970-1990, 15 % of all innovations were the fruits of independent innovators. In the period of 1990-2007 independent innovators accounted for 16 % of all innovations. *This inquiry hence does not find that innovation by independents has increased over the period studied.*

7.1 Analysis of results

The number of innovations by independent innovators is lower than the numbers found in previous research outlined in this thesis. Since the three studies cited on the prevalence of independent innovation use different methods than this one (one uses patent analysis, two case studies) it is a bit difficult to know how much this means; it may be a question of how independent innovation has been defined in each case. The patent study also does not necessarily indicate the situation for actual innovation, since not all patents a commercialized and not all innovations are patented. It could also be that these results simply reflect the situation in this sector, as compared to the other studies that uses examples as a whole.

Given the findings of Sandström, Sjöö and Talbi suggests an increase in independent and small firm innovation, one might find it surprising that my findings does not indicate an increase in the importance of independent innovation. However, the explanation can possibly be sought in the definitions. Sjöö uses the lowest level of innovating agent that SWINNO allows, the firm, to analyze trends. Therefore the fact that she find a growing importance of

small firms as innovation agents could mean that the majority of inventors responsible for innovation are still employees - just at small firms. The contradiction to the increase in small firm importance in Taalbis description of the telecommunications sector can be explained in the same way. In the case of Sandström, he has indeed classified independent innovation, but the criteria for the different categories used are not discussed in detail. Hence, this may be a matter of different definitions of independents. According to the results, in the light of previous research, it seems clear that small firm innovation has increased, but not necessarily the number of independent innovators.

The finding that most independent innovators commercialize via the entrepreneurial route is in accordance with previous research outlined in this thesis. Given the previous findings that those inventors who commercialize through entrepreneurship have a higher chance of reaching the market and of generating higher profits it seems plausible to find more inventor-entrepreneurs. However, the results of this thesis suggest that the dominance of the inventor-entrepreneur is rather new. This would also seem plausible in light of Sjöö's and Taalbi's findings of increased entrepreneurship.

7.2 The innovators found

The independent innovators identified in this inquiry seem to be close to the norm in many regards. The typical innovator found was male; in fact, all independent innovators in this inquiry were male. This is only too consistent with the conclusions of previous research on the demographics of independent innovators, and indeed of inventors on the whole. As have been mentioned, patent statistics also mirror these truths. Is innovation thus a male activity? Although it seems obvious that creativity cannot possibly be a question of gender, and there are a multitude of examples of female inventors that have made huge contributions to science and technology, the empirics seems not to convey this. Can it be a question of the narrative influencing reality? A recent study found that creativity as an character trait is more often associated with masculinity and men are seen as more creative than women (Mikulak 2015). By allowing reports created by men and women to be judged blindly, it was proven that it was not the work of women that was seen as less creative, but actually the woman herself. This kind of prejudice and effects of it on inventive activity might have led to a situation where only half the population innovates.

Furthermore, the innovators found in this sample were in accordance with previous findings in that they seem to be highly educated. Several were at the very highest end of the

educational spectra as university researchers. Many of them reported having a engineering degree, in subjects like physics and applied sciences. Combining the educational standards of independent innovators with the findings of Amesse that they also tend to be high-income earners, underlines the message that innovation does not seem to an activity conducted by broad segments of society. Given the revered place innovation holds in our society today (indeed, we might live by an innovation ideology), further analysis of this apparent lack of democracy would be most interesting. What does it mean that large part of society does not participate in something we put so much hope and resources into? However, to return to the stories that inspired this thesis, these findings of the sleek rich innovator does not exactly square with the image often painted in anecdotal inventor stories, in which the innovator is a quirky old man with raving hair who operates from his backyard shed.

Out of the 44 innovations by independents in this material, 11 was reported to be patented. Some of the innovators reported a development time; the average seems to be around five years. This is consistent with the previous research described. However, a few reported that they had developed an idea that they had carried with them for more than a decade.

As discussed, Granstrand and Alänge finds that there is a considerable dynamic interplay between Mark 1 and Mark 2 innovation actors. This tendency also exists this inquiry. In 8 cases innovators had been employed by Ericsson before they became inventor-entrepreneurs or inventor -inventors. One utilized knowledge acquired while working as consultant for the large firm to spot current product weaknesses. Another decided to build on technology that had been scrapped by the firm. It is also clear that experience as an employee in the sector is beneficial, as several innovators have many years of work experience in the field. In the cases where the innovator has been a researcher at a university, it is obvious that their past work experience has been relevant. One example of such a case is Bengt Hallberg who used to be a researcher at the Institute for Optical research at the Royal Institute of Technology in Stockholm, before starting his company BOH Optical to develop a transmitter system for optical cable.

When innovating is not inspired by work experiences, everyday problems can be the trigger. Upon moving to the far north of Sweden one innovator with long experience from technical development found himself in need of a better antenna. He simply decided to developed one. Later he started a business to commercialize his invention.

Some inventors in this inquiry are portrayed as professional or serial innovators. These hold a great many patents and have been inventing for a long time. They may only be part time devoted to innovation, as was the case for Johan Ullman who divided his time between innovation and being a doctor. Others are completely immersed in their projects and may run their own innovation firms full-time. Described as long time serial innovators were Håkan Lans, Christer Fåhareus, Karl-Erik Leeb and Kalle Ståhl.

The innovators that are most recognizable from anecdotal evidence are probably those who seem completely consumed by their activities. One example of that kind of innovator find in this inquiry was Bo Bengtsson who develops speakers. The article describes his lifelong interest in technical equipment and how he spends 24 hours a day developing and marketing his products.

The opposite of the serial innovator is the occasional innovator who may have never innovated before but has stumbled upon a problem and attempted to solve it. These innovators have likely not left their current jobs and careers to pursue innovating full time. There are a few examples of this in the material. One is radiologist Ulf Nilsson who developed a special device for sending images of x-ray sheets between doctors.

8. Conclusion

Today, innovation is gospel. This makes innovators the new gods, and the idea of the "one brilliant man" flourishes. But is the lone inventor narrative a reasonable way to think about innovation? In this thesis, the narrative from the anecdotes was tested empirically. By utilizing the records of the SWINNO-database of innovation, the agents behind innovation in the Swedish telecommunication sector over the period 1970-2007 has been classified as employees, inventor-entrepreneurs or inventors-inventors, in order to trace instances of independent innovation. The results found that independent innovation was only behind 16 % of innovations in this sector. There was no significant change in their share from the first half of the period to the last. Of the independent innovators, most were inventor-entrepreneurs, meaning that the commercialized their inventions through a firm of their own. The results of this inquiry proves that, while romantic, the narrative of lone inventor is not a good representation of innovation activity at large. Rather, most innovation is the fruit of the labors of employees. However, it is not the case that the independent innovator is a purely mythical character. He is most existing, contributing to science and the economy and does not seem to be going anywhere. Neither superhero or lunatic, this economic actor therefore deserves

continued and deepened interest to better define the phenomena that is the independen innovator.

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Appendix

Table 1. Results from classification

		1.Employee	2.Inventor-entrepreneur	3.Inventor-inventor	4.Independent innovators (2 + 3)
1970-2007					
No. of innovations in the period:	283				
No. of innovations by actor:		239	34	10	44
Percent by actor:		84 %	12 %	4 %	16 %
1970-1990					
No. of innovations in the period:	101				
No. of innovations by:		86	8	7	15
Percent by actor:		85 %	8 %	7 %	15 %
1990-2007					
No. of innovations in the period:	182				
No. of innovations by actor:		153	26	3	29
Percent by actor:		84 %	14 %	2 %	16 %