Market Structure and Innovation: Determinants and Conditionality in a Schumpeterian Framework

An empirical study of recent U.S. industry-level innovation data

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Abstract

Schumpeterian theory regards innovation as the main engine for economic growth and assigns a major role to market structure in determining innovation. Complexity of this relationship and poor quality of data however yields high ambiguity of both theoretical and empirical literature on the topic. This study provides new evidence on the relationship between market structure and innovation by analyzing new U.S. industry level innovation data and assessing the quality of the new data in measuring innovation. Next to assessing previous findings with new data, a theorized conditional relationship between market concentration and dynamics on innovation is empirically studied. Controlling for size, entrepreneurship and in particular industry effects, we find evidence of a positive individual effect of market concentration and market dynamics on innovation. Excluding industry effects, we find evidence of a conditional relationship as well, positively affecting innovation when concentration and dynamics take contrasting values. From analyzing new innovation data we conclude that contributions to the Schumpeterian innovation debate, such as our findings, can still be made; further collection and analysis of new data will therefore shed more light on both the conditional relationship as the complexity of market structure and innovation.

Keywords: Conditionality, Innovation, Market Concentration, Market Dynamics, Market Structure, Schumpeter

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1. Introduction

"Innovation is a quest into the unknown. It involves searching and the probing and reprobing of technological as well as market opportunities. With hindsight, much effort is spent traveling down blind alleys." – David Teece, 1996

When Joseph Schumpeter wrote his *Theory on Economic Development* in 1934, he referred to innovation the "*leading engine for economic growth*", not knowing that his works would still be relevant over 80 years later. The 2008 Innovation Measurement Report shows why: "*While we recognize that the American economy is changing in fundamental ways—and that most of this change relates directly to innovation—our understanding remains incomplete"* (Schramm et al, 2008, p. 7). Summarizing, the report states that nowadays both academics and business still know very little about innovation, its origin, how it is measured and its precise connection to economic growth. As Teece (1996, p. 2) states that searching, probing and reprobing in opportunities for innovation often leads to wasted ('*blind alley*') effort, so concludes the *Advisory Committee on Measuring Innovation in the 21st Century Economy* that much of the current studying of innovation does not lead to increased understanding. Attributing the lack of proper innovation measurement as causing this, the report urges the need for improved measuring methods, targeting increased insights in the ongoing debate on innovation.

So far, research based on often poor quality data does not result in consensus on how to measure innovation best or whether Schumpeter's theories can also empirically show innovation causation. On the one hand regarding innovation measurement, methods of measuring R&D, patents or innovation counts as proxies for innovation all show to have (multiple) defects. On the other hand shows research of market structure, entrepreneurship and innovation evidence both supporting and contradicting whether or not concepts of market structure stimulate innovation. Literature finds no straightforward conclusions, although the body of research conducted to study innovation and its roots in market structure is extensive (e.g. Kamien & Schwartz, 1982; Nelson & Winter, 1982a; Cohen & Levin, 1989, 2010). The most recent publication by Cohen and Levin (2010) describes the current status of the debate on market structure and innovation as 'problematic' due to the lack of robust empirical evidence. Hereby Cohen and Levin press for research of better quality data, with the purpose of developing a deeper understanding of innovation determinants and the conditionality of innovation on industry-level factors (Cohen and Levin, 2010).

In this thesis I analyze new innovation data, studying the quality of this data in measuring innovation compared to previous innovation research, in the framework of Schumpeterian theory on innovation. Second, I use the new data in extending knowledge of innovation origin by analyzing the gap in research on market structure and innovation. Assessing the research gap means theoretically and empirically substantiating the presence of a conditional relationship between market structure concepts concentration and dynamics on innovation, which the literature only mentions laterally. In conducting this study, I employ the following research question:

"What empirical insights can analysis of recent innovation data add to the debate on Schumpeterian innovation determinants and conditionality?"

Contributions to the research debate result from the analysis in twofold. First, the new data on innovation shows to be consistent with previous innovation research finding evidence of market structure stimulating innovation, taking into account interfering variables. Suffering less from measurement biases and contradicting outcomes in analysis, we argue the superiority of the innovation data used. Secondly, we find evidence for the conditional relationship of market concentration and dynamics, stimulating innovation when concentration and dynamics take contrasting values. Including industry effects, however, results in insignificance of the relationship, which shows the importance of incorporating interference and control variables.

The thesis is structured as follows. **Section 2** reviews relevant theoretical and empirical literature. We start with theory on Schumpeter's *Mark I* and *Mark II* models and Neo-Schumpeterian theory, focusing on concepts of market structure and innovation. Next, we discuss empirical research on innovation and Schumpeterian theory, elaborating on developments in theory and major issues encountered. Here we find the research gap and state hypotheses for analysis. **Section 3** discusses methods used to study these hypotheses. **Section 4** presents the results of analysis, which we discuss in **Section 5**. This last section evaluates findings in the perspective of theory, literature and hypotheses, finalized in answering the research question formulated above.

2. Literature Review

Economic theory by Joseph Schumpeter originates in the late 19th century, but still is remarkably relevant and produced "*the second largest body of empirical literature in the field of industrial organization*", as Cohen and Levin (1989, p. 2) state. Ongoing relevance is due to the great role assigned to innovation in economic theory, but also because of the high ambiguity of market structure and innovation in terms of theoretical substantiation and empirical measurement.

We derive two central theories of specific relevance to the thesis from Schumpeter's major works *Theory on Economic Development* (1934) and *Capitalism, Socialism and Democracy* (1942). The so-called Schumpeterian patterns of innovation have become known as *creative destruction* and *creative accumulation*, as defined in post-Schumpeterian research by for instance Breschi (2000).
In the following we define the concept of innovation, succeeded by discussion of the two patterns of innovation, referred to as Schumpeter *Mark I* and *Mark II* (Nelson and Winter, 1982a; Kamien and Schwartz, 1982). Shortly, we state some key points of Neo-Schumpeterian theory next, providing a transition from theoretical framework to the literature review section.

2.1 – Schumpeterian Theory

In order to have a clear image on the concept of innovation, we state innovation following Schumpeter's five-point definition in *Theory on Economic Development* below:

1. Introduction of a new (quality of a) good, thus far non-familiar to consumers
2. Introduction of a better or improved method of production, through methods ranging from scientific discovery to improvement of product commercialization
3. Opening of a non-existent market or entering an existent market of which the manufacturing branch in question has not been part of before
4. Obtainment of a new source of supply (be it raw materials or half-manufactured goods), irrespective of whether this source already exists or has first been created
5. Improvement of industry organization, for instance by creation or breaking up of a monopoly position

Since Schumpeter's definition various definitions have followed, often building on the five points of the definition above. Following this path, recently Schramm et al (2008, p. 11) define innovation as "*the design, invention, development and/or implementation of new or altered products, services, processes, systems, organizational structures, or business models for the purpose of creating new value* *for customers and financial returns for the firm*" in their advisory report on innovation measurement, all the more confirming current day relevance of Schumpeterian innovation.

Mark I & II

Although specifically named as such in Schumpeter's later publication *Capitalism, Socialism and Democracy*, his 1934 work *Theory on Economic Development* describes the process of creative destruction within an industry. In Schumpeter's own words called the "*perennial gale of creative destruction"*, it is "*the process of industrial mutation that incessantly revolutionizes the economic structure from within, incessantly destroying the old one, incessantly creating a new one*" (Schumpeter, 1942, p. 83-84). Creative destruction centers entrepreneurial firms in generating innovation; innovative firms enter an industry and successfully replace incumbent firms bowing on previous innovations, making sustainable positions of market power impossible (Fontana, 2012). The market structure of the *Mark I* industries stimulates firm entry: little or no entry barriers combined with competitively turbulent environments provide entering (entrepreneurial) firms with the ability to constantly disrupt the established market order. For this reason, long term firm positions in the market are untenable and a continuing flow of innovative activity follows. Breschi (2000) labels these Mark I industries '*widening*', as the innovative base is continuously enlarged by the entry of new innovators and the erosion of incumbent firms' positions, resulting in a high instability in the hierarchy of innovators.

Later on, in *Capitalism, Socialism, and Democracy,* Schumpeter revisits his view and propositions relating to the *Mark I* theory, mainly with respect to the position and behavior of large incumbent firms. Shifting the focus to highly concentrated monopoly markets as generating innovation, Schumpeter's *Mark II* theory is positioned "*almost diametrically opposite*" to his *Mark I* theory (Sidak, 2009, p. 587). Cantwell (2000) argues that after his early work on entrepreneurship, Schumpeter noticed the increase in R&D activity by and within large (powerful) firms, causing him to develop the *Mark II* theory. This theory envisages innovation as "*a more routinized process within large firms*" (Cantwell, 2000, p. 3). Large oligopolistic firms now function as the key agents for innovation, originating in the power they possess due to their large share of the market (Cantwell, 2000). In industries characterized by a stable competitive environment and presence of entry barriers, large incumbent firms produce innovations. These conditions enable the large incumbents to use their competencies in R&D; production and distribution; financial resources and accumulated stock of knowledge in specific technological areas to innovate (Breschi, 2000). Simultaneously, these competencies ensure maintenance and strengthening of market entry barriers, making loss of monopoly position through market disruption an incredible threat. Among others, Breschi refers to this process as "*creative accumulation"* (2000, p. 3) and labels it as *deepening*. The label '*deepening*', according to Breschi, describes the accumulation of continuous innovation by a few dominant firms over time (2000).

Although stated as diametrically opposite, this does not mean that Schumpeter *Mark I* and *Mark II* are contradictive, as we find that nowadays *Mark I* and *Mark II* are regarded as complementary. It is the whole of market conditions that gives lead to a *Mark I* or are *Mark II* scenario, in which possibility of market entry and the competitive environment are core characteristics. Moreover, the evolution of markets from *Mark I* to *Mark II*, and vice versa, is also possible (e.g. Klepper; 1996, and Henderson; 1990), as entry barriers and conditions of competitiveness are non-static in a developing market.
Note that, keeping in mind the favorability of a monopoly market in *Mark II*, Schumpeter's argument is that perfect markets are not compatible with innovation, as Schumpeter (1942, p. 105) argues that "*The introduction of new methods of production and new commodities is hardly conceivable with perfect–and perfectly prompt–competition from the start. And this means that the bulk of what we call economic progress is incompatible with it*".

Neo-Schumpeterian Theory

Schumpeter's two central theories can hardly be seen as definite. Highly unmathematical in nature and empirically flawed, Neo-Schumpeterian economists made great effort in further developing the '*Schumpeterian hypothesis*' of market power-based innovation. Hanusch and Pyka describe Neo-Schumpeterian theory as extending Schumpeter's *Mark I* and *II* by bringing together firm behavior on the micro-level; industry dynamics on the meso-level and innovation driven growth and competitiveness on the macro-level (2005). In their own research, for instance, Hanusch and Pyka (2005) extent Schumpeter's models by including the public and financial sectors. For our analysis we focus on concept of the *Mark I* and *Mark II* industry level models and Neo-Schumpeterian developments regarding these concepts, centering market concentration and dynamics in analysis.

2.2 – Empirics of Innovation

Ever since Joseph Schumpeter published his *Capitalism, Socialism and Democracy* in 1942, innovation as the object of analysis has become increasingly eminent in economic research. However, scholars have used three very distinct operationalisations of the concept innovation. The first and dominant one is research and development (R&D). Many acclaimed scientists use it in their research since this data is readily available (e.g., Dasgupta & Stiglitz, 1980; Levin et al., 1984, 1985, 1987, 1988; Mansfield, 1968). However, a similar amount of research emphasizes the flaws of this measure, since R&D is merely input for innovation and "*that is not enough. Outcomes of innovative activity need to be tracked* *and measured to determine fully the impact of innovation on the economy"* (Schramm, 2008, p. 11). Due to the broadness of the concept *R&D*, varying interpretations lead to heterogeneous data and errors in reporting (Cohen & Levin, 1989). Hollander (1965) argues that considerable effort is devoted to (technological) innovation not labelled R&D; Bloch and Brugge (2013) state that innovating without conducting R&D widely takes place through firm value chain linkages and learning capacity. Lastly, Kleinknecht (1987) states that small firms usually do not conduct (formal) R&D. Does this mean that all research using R&D as proxy for innovation is biased? Not necessarily, but it does show the difficulty of adequately measuring the concept of innovation.

The second measurement is patents, measuring innovative output. This measure is frequently used to approximate innovation in much cited papers as well (e.g., Basberg (1987), Mansfield (1981, 1986) and Scherer (1965b, 1983)). As patents is a result from an innovative process, one can argue that patents proxy innovation better. Pavitt (1985) substantiates this by stating the widespread use of patent data and example cases, finding evidence of innovative activity without R&D activity.
Again, however, significant problems arise, for example according to Cohen and Levin (1989). Most notably is the fact that value from patents is highly heterogeneous and the larger part of patents is not commercially exploitable. Moreover, in cross-industry analysis there is considerable variety in propensity to patent. Next to Cohen and Levin, Pavitt (1985) finds that there is a tendency to *over-patent* rather than to *under-patent* (decreasing the average generated patent value). Finally, Coombs (2000) puts a question mark to the relevance of patents in industries outside of manufacturing industries, as patents are in manufacturing. Reviewing the literature, we also find multiple shortcomings for the patenting method of measuring innovation, making this method is not undisputed either. Still, using patents is often preferred over the R&D method.

The third and last innovation measurement is innovative products and services. This is probably the most direct measure of innovative output, but simultaneously the most difficult to collect. Due to greater data availability, innovation research increasingly uses this method: Robson and Townsend (1984) collected cross-industry innovation counts for the U.K. and study sectoral patterns and trends in production and use of innovations (Robson, Townsend & Pavitt, 1988). Although very heterogeneous in terms of innovations' economic value and prone to biases, the authors refine the method Mansfield initiated for individual industries (Mansfield, 1963). The measurement of innovation was then picked up by others (e.g., Acs & Audretsch (1987a, 1987b, 1988), Geroski (1990) and Wilson et al (1980)). Regarding this method of innovation analysis, Archibugi (1996) notes that in order to distinguish in economic value, making a clear distinction between incremental and radical innovations is important due to the heterogeneous nature and value of new products, processes and services.

Archibugi (1996) concludes that the advantage of innovation counts is that it includes services industries in analysis. On the other hand, biases may occur when analyzing heterogeneous innovations in a homogeneous setting (for example cross-country).

Trends in Innovation Research

More recent development in innovation analysis show an increasing awareness of stated biases and want for better methods to capture the concept of innovation (Schramm, 2008). More recent research explores different ways to measure innovation. An example of this is the approach of Hagedoorn and Cloodt (2003), where they take a combination of indicators described above as measuring method. The authors formulate a method called *innovative performance* and substantiate the claim of its superiority over individual measures through the Venn diagram below.

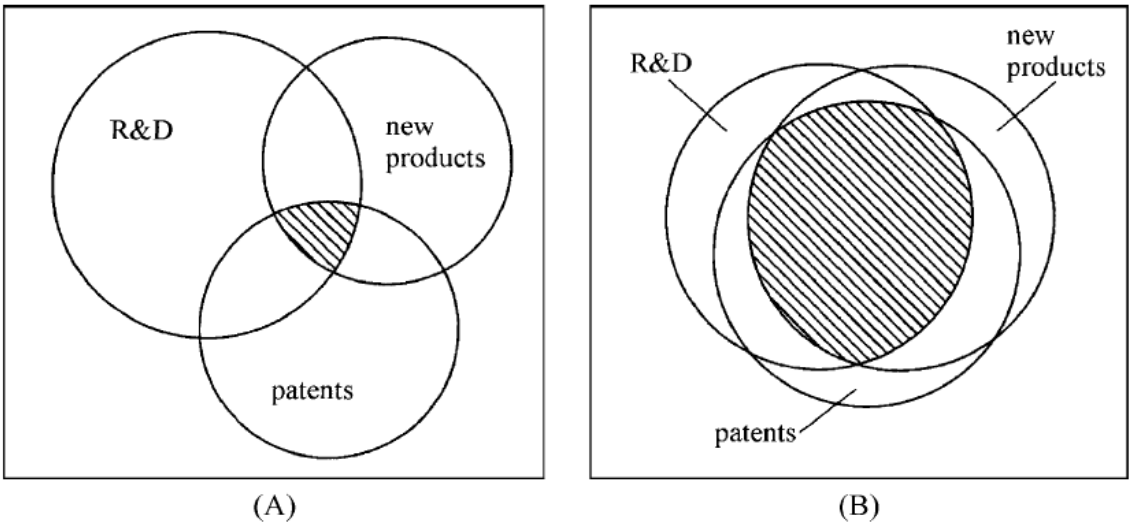

Figure I: Venn diagram modelling innovative performance

The index of three measures approximates the concept of innovation best and therefore analyzes innovation in its real form, with the sole requirement of available data on all index components.

2.3 – Market Structure and Innovation

Market structure comprises a great range of factors, from which a select few are highlighted; competition (comprising market power/concentration, inversely related to competition) and market dynamics (in terms of the flow of firms). On the one hand, the selection of these factors is due to practical reasons (i.a. data availability for analysis), but on the other hand we find that the majority of past studies on the topic includes these factors as well, therefore strengthening the extent to which our analysis and its findings can be compared to previous research.

Market concentration and competition

Nothing becomes more evident from research on innovation and market structure than the complexity of the relationship. Initially theorized as a partial equilibrium between market power, entrepreneurship and innovation by Schumpeter in 1942, researchers have always intended to study the complete equilibrium in which market power is an important factor, but at the same time only one of many links. Research therefore studies the *ex-ante* (one-way) relationship between market power and innovation, hence directly testing Schumpeter's conjectures (Cohen & Levin, 2010).

Arrow (1962), theorized that a market with a higher level of competition would result in higher gains from innovation at the margin, since innovating in a monopoly market (by the monopolist) leads to partially replacing monopoly returns that were already earned beforehand. This means the more market power, the less incentive to innovate. Gilbert and Newbery (1982) oppose this by arguing that monopolists have a greater incentive to focus on innovation due to the monopolist's risk of losing its position in the market. Research by Dasgupta and Stiglitz (1980a) incorporates barriers for market entry and finds a positive correlation between concentration and (industry) R&D in the case of free-entry markets with a low level of market concentration. However, if barriers to entry exist (and thereby protect a monopolist's position); these barriers, in combination with risk of failed R&D investment, causes the pure monopolist to have insufficient incentive to innovate and to '*engage in risky research ventures*'. Competitive markets, Dasgupta and Stiglitz theorize, however do induce firms to engage in (risky) research and development, since the first firm to succeed gets rewarded the most for innovative behavior in terms of for example cost advantages (1980a). Eventually though, as a higher level of competitiveness induces more firms to take risk in performing R&D, risks increase even further and the accompanying pressure of competition ensures that the amount of firms able to perform R&D decreases, in the end resulting in declining R&D intensities (Dasgupta & Stiglitz; 1980a; 1980b). Herewith, these author already touch upon the complex nature of the relationship: the theorized effect of market power on innovation is not static in nature, but dynamic for different levels of competitiveness and concentration. Scherer (1980), subsequently, argues that the 'isolation from competition' in case of high market power (such as a monopoly) results in 'bureaucratic inertia' and therefore discourages innovation. Porter (1990) extents this argument by substantiating the case of low market power; he states that a high level of competition means active pressure from rivals and more intense rivalry, both contributing to the need to innovative.

Cohen and Levin (2010) summarize fifty years of empirical studies on innovation and find that the multitude of empirical studies show a positive relationship between market concentration and innovation measured in terms of R&D. The summary is similar to earlier works of Scherer (1980), Kamien and Schwartz (1982) and Baldwin and Scott (1987), but is the most recent and therefore used.

Among those who find a positive relationship are Horowitz (1962), Hamberg (1964), Scherer (1967) and Mansfield (1968). A small body of research finds opposing evidence as well, e.g. Bozeman and Link (1983), Mukhopadhyay (1985) and Williamson (1965). Geroski (1990) uses a measure of innovative output, counts of commercially significant innovations, and finds a positive relationship between competition (comprised of market concentration, measures of entry and exit, and small firm count) and innovation as well. Blundell et al (1999), argue that overall market concentration is of negative effect on innovation (measured by the number of commercially significant innovations, limited to 340 firms): they find that 'less competitive' industries, in which the concentration level is relatively high, had fewer aggregate innovations. Nevertheless, they also find that firms with a high market share tend to be among the leading innovators in highly competitive and innovative industries. Which indicates that high market share firms have incentives to innovative in very competitive markets as well. Next, using a model with stock market value as proxy for market concentration, results show that a higher stock market value relates to increased innovative activity. Additionally, firms with a higher share of the market tend to benefit from innovating most (confirmed with patent data analysis). Large firms' innovative dominance in highly competitive markets is in the end attributed to pre-emptive innovation (incentive to innovate in order to prevent the loss of a favorable position in the market); difference in intrinsic quality of innovations between leading and smaller firms, and advantages due to greater access to capital (Blundell et al, 1999).

An inverted-U relationship

Findings above give reason to suspect that the relationship between competition and innovation is non-linear in nature: market concentration effects on innovation are not equal for all concentration levels. Scherer (1967a) was the first to examine this argument, titling it the 'inverted-U' relationship between R&D intensity and concentration. Taking R&D employment as a measure for innovation, Scherer found that R&D employment increased with industry concentration up to a (four-firm) concentration ratio of 55% and decreased for higher concentration ratios. Using different data (Federal Trade Commission business data), Scott (1984) and Levin et al (1985) were able to replicate this finding. More recently, Aghion et al (2005), took an averaged Lerner Index (market power measured by cost margin) to proxy intensity of competition and the average number of citation weighted patents as a measure for innovation; a model that results in a similar 'inverted U' relationship. The authors explain this relationship in twofold, for the cases of low- and high levels of concentration. In the case of low level concentration, firm rivalry takes the shape of 'head-to-head' competition. In this case an increase in the intensity of competition means an increased incentive to innovate, since the authors find that innovating results in higher profit for the innovator than before the innovative activity. Due to the competitive character of the market, being innovative pays off and the innovating firm is able to

‘escape from competition’. Regarding the latter case, high levels of concentration, there is a leading and a lagging firm in the market. Here, greater competition intensity only discourages the laggard to innovate: there is not much to gain since post-innovation returns remain low due to the persistent position of the firm as laggard, opposed to the leading firm. In other words, the lagging firm is not capable to change its position as laggard to leader by (one-step) innovation (Aghion et al, 2005).
In brief terms: competition can either increase or decrease innovation, depending on the distribution of the forms of rivalry in the economy (Cohen & Levin, 2010).

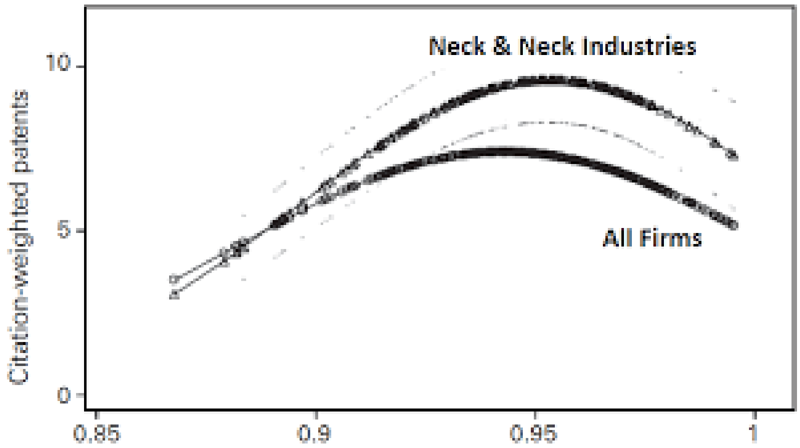

Figure II: The inverted-U relationship between competition and innovation

Although the highly stylized character of the model by Aghion et al has to be taken into account, especially with respect to the division in just two forms of rivalry, research by Lee (2009) confirms this simple distinction, observing that competition intensity can stimulate the more capable (leading) firms to increase investment in R&D, as at the same time less capable (laggard) firms invest less.

Assessing some aspects of the relationship, we examine the specific characteristics of the relationship between competition (and inversely concentration) and innovation. This however, does not mean that the literature is exhausted; the lengthy summary studies prove this. It becomes clearer that in general, we observe a tendency to ‘connect the dots of the complete picture’ regarding market structure and innovation; including an increasing amount of variables with perceived relevance continuously extends research on competition and innovation. Nicholas (2003), for example, focuses his research on Schumpeterian context (studying the 1920’s) and in a great deal of research attention is directed towards firm characteristics, for instance by Kraft (1989), who includes workforce skill level in the equation.

Market dynamics

Stated as a necessity to understand the link between market competition and innovation, Cohen and Levin (2010), strongly endorse the inclusion of market dynamics (in terms of market entry) in empirical analysis. This argument stems from research by Geroski (1990, 1991a, 1991b, 1994) and Acs & Audretsch (1991a), who study the relationship between (general) market structure, market entry and innovation. Geroski (1991b) finds a positive relation between entry and innovation, and shows by means of Granger causality that the relationship originates in firm entry (additionally including industry fixed effects). In a later study, the same author finds that a market with high technological opportunity drives both entrants *and* incumbents to innovate. Potential entering firms are stimulated to enter such markets, as technological opportunity enables these firms to capitalize on (pre-entry existing) inventions (Geroski, 1994). Following this path, Gans et al (2002) state that the degree to which entrants are protected and enabled to conduct their business (for example by patenting effectivity and technological opportunity) is of importance for their decision to enter a market and subsequently contribute to innovation.

A year after his 1994 publication, Geroski surveys existing empirical work on entry and concludes by means of stylization that "*high rates of entry are often associated with high rates of innovation and increases in efficiency"* (1995, p. 431). Not only does firm entry correct for static market equilibria (so, affecting market dynamics), it also contributes to growth and development in general, Geroski argues. More studies by Geroski (1989a) and Acs and Audretsch (1990) also come up with positive correlations between entry and innovation rates, and Baldwin and Gorecki (1991) find that for (normalized) Canadian industries, industry entrants attribute 24% of productivity growth.

Market dynamics and market concentration

Next to his findings on firm entry and innovation, Geroski (1995) pays attention to the close interconnection of market concentration in this relationship. As firms enter a market, this affects market composition and thereby market concentration, in which entrants can pose a threat to incumbents' positions and (artificial) scarcity. Geroski's arguments on behalf of this issue remain confined though: based on empirical research by Biggadike (1976), Robinson (1998) and others, he argues that incumbents' response to entry is limited and selective. Following the Sylos Postulate that incumbents will not change pre-entry output levels post-entry, the author argues that incumbents' (pre-entry) choice of output level ensures non-positive profits for entering firms and therefore entry might not even occur, leaving market concentration unaffected. On the other side, though, entering firms achieve at least a non-zero market share, which should provide (large) incumbents with the incentive to deter entry anyway (Geroski, 1995). Interpreting these findings and implications remain '*a little tricky*', as Geroski states it.

Cohen and Levin (2010) summarize Geroski's work by stating that market entry creates the potential for innovation and the intensity of competition affects entrants' scope to conduct innovate activity. More but few other studies on the linkages between entry and market concentration can be found:

Acs and Audretsch (1988) study small firm entry and find market concentration to be deterring entry; according to Loury (1979), high firm entry induces increased competition (for an attractive market in terms of R&D activity) as the volume of firms exceeds the social optimum, leading to decreasing innovation in terms of investment in R&D.
Remarkably, however, is the lack of empirical research studying the conditional effect of market concentration and market dynamics on innovation. Especially since we observe individual correlation between market concentration, market dynamics and innovation, lengthwise and crosswise. Our analysis empirically tests this gap in the literature.

Endogeneity: interference and simultaneity

In the end, studies summarizing the literature on innovation and market structure, like Cohen and Levin (1989; 2010) and Symeonidis (1996) do all agree that due to the variety and even contradictory character of research results, empirical findings are "*most accurately described as fragile*" (Cohen and Levin, 1989, p. 1078). This conclusion, derived from the many intervening factors complicating research, has major implications.

Assessing the many factors at play in the studied relationship, the wait is for identification of endogeneity issues. As Symeonidis (1996, p. 42) states; "*within a complex equilibrium system, market structure and innovation are all endogenously determined*". Schumpeter already touched upon this by succeeding his statement of *ex ante* effects (see before) with *ex post* effects of market power and innovation: as market power affects innovation, consecutively, the changing degree of innovation impacts market power as well. Neo-Schumpeterian research addressed this *ex post*-claim by studying issues of endogeneity. Phillips (1966) was one of the first to propose that causality might also run from innovation to market structure, arguing that '*success breeds success*': a more concentrated industrial market structure results from innovation. Theoretical support by Nelson and Winter (1978, 1982b) and Sutton (1998) succeeds this proposition, as did empirical substantiation by Mansfield (1983). Efforts to correct by means of instrumenting market concentration follow, using market share (Blundell et al, 1999) and the Lerner index (Aghion et al, 2005), which we discussed. Aghion et al (2009), instrument for endogenous entry with policy reforms and find presence of endogeneity regarding entry as well. Besides this, multi-equation models treating both concentration and innovation as endogenous are estimated (Levin & Reiss, 1984, 1988; Connolly & Hirschey, 1984; etc.). Although some of these studies find evidence of endogeneity, others (Howe and McFetridge, 1976) find little difference in coefficients when estimating a 2SLS model. Endogeneity, though likely present in the forms of simultaneity and direction of causality, remains hard to ruggedly substantiate.

Next to issues of bilateralism, research has also found many factors confounding the relationship between market structure and innovation. Therefore, to control for sensitivity of the relationship to industry-level factors, research includes these in analysis. We find in particular industry (fixed) effects (Scherer, 1967; Scott, 1984), entrepreneurial effects through firm size and firm age (Utterback & Suárez, 1999; Shefer & Frenkel, 2005), and a proxy for technological opportunity (Malerba & Orsenigo, 1995, 1996, 1997; Roelandt, 2003) to be intervening the relationship between market structure and innovation. Cohen and Levin (2010) endorse the incorporation of technological differences within an industry (or technological opportunity) into industry effects, originating in research by Geroski. This study (1990) interprets industry fixed effects as reflecting technological opportunity and finds that leaving out industry effects reverses the outcome of a positive relationship between competition and innovation. The results of including the control variables on the studied relationship, however, varies: Scott (1984) adds industry fixed effects and finds that the relationship is no longer significant, while Levin et al (1985) retains significance but obtains an order of magnitude drop in coefficient size, conducting the same research with slightly different data. Controlling for technological opportunity, Lunn and Martin (1986) find significance of concentration on innovation only to hold for low opportunity industries. Archibugi and Evangelista (1995) find differing results as well; when controlling for firm size they find that larger sized firms show to be more innovative. Shefer and Frenkel (2005) mention interference of labor skill level. Of course, we can identify many more variables to control for, ranging from financial constraints (Wedig, 1990) to advertising intensity (Comanor, 1967) and appropriability of innovation profits (Cohen et al, 1987). These, however, are not in the scope of our analysis (in part due to data limitations).

Concluding, we can agree with the statement of Cohen and Levin (2010) that market concentration on its own is not an independent and straightforward determinant of innovation; too much indeterminacy in the theory and inconclusiveness in empirical results is present to disprove this statement. We keep both this limited understanding of economic forces driving innovation (as Symeonidis (1996) states) and the difficulty of capturing market structure related theory in data in mind when determining the scope of our analysis. In other words, the research gap is (technically) still enormous and comprehensive, since there is low availability of robust discoveries on the topic.

2.4 – Research gap: hypotheses for analysis

In examining relevant theoretic and empirical literature, we have found a number of gaps in research. We will address a selection of those in our analysis and elaborate on these in two parts: innovation research in general and more specific the conditional effect of market concentration and market dynamics on innovation. Although we spoke to some extent of endogeneity, it falls outside the scope of this thesis to find and include a correction for this effect, particularly since the empirical literature on endogeneity is not able to find an unambiguous effect, let alone robustly correct for it.

Empirics of innovation

In the review of the literature on innovation analysis we have assessed the three most prevalent measures of innovation: R&D, patents and new product, process and service innovations (innovation counts). We have stated advantages and disadvantages, which greatly affect a measurement's capability to assess innovation, applying to the relationship between market structure and innovation as well. For the thesis analysis we collected recently released data on U.S. industry level, enabling us to analyze innovation and the effect of market structure on innovation with proposedly superior data. In doing this, we answer to the call of Cohen and Levin (1989) when they state "*finally, given the limitations of available data, advances in our understanding of innovation and market structure will depend importantly on the development of new data sources*", since the collected data on innovation has not been used in analysis yet. Therefore, the following hypotheses are stated:

Hypothesis 1: *'Market concentration and market dynamics positively influence innovation'*

Conditionality: market concentration & market dynamics

Using new innovation data from the U.S., we extend research on market structure and innovation by studying the presence of a conditional relationship between market concentration and market dynamics on innovation. We expect this relationship to be detrimental, following past literature (for example Loury, 1979). In the analysis, we control for as many of the confounding factors found in the literature as our data allows. We specifically focus on the impact of industry fixed effects which the literature perceives as most important, expecting its interference to reduce other factors' effect size. To find out whether control variables besides industry effects are as significant for the new data as observed in the literature, we assess control variables as well. The accompanying hypotheses are:

Hypothesis 2: *'There is a negative conditional relationship of market concentration and market dynamics on innovation'*

Hypothesis 3: *'Interfering variables negatively affect innovation'*

3. Methods

In order to test the hypotheses as described above, we use recently (as of 2007) released data on innovation. Due to broader collection of the data, analysis now also comprises non-manufacturing industries instead of being limited to manufacturing industries. Using the full extent to which the newly available data is collected, we are able to replicate research as found in the literature and add to the current research body via the analysis of the second and third hypotheses.

3.1 - Data

Determinative for proper research is the data collected and used for analyzing. We found this issue to be addressed to a great extent in past empirical innovation research, especially when it comes to the measurement of innovation used.

Table 1 provides an overview of the data collected and used in analysis, as well as its sources and the naming of model variables. We shortly highlight data classification, availability and innovation data.

Table 1 – Variable Definitions and Data Sources	
Dependent variable	
Innov_Ratio	Innovation Ratio; firm introducing innovative product, process or service divided by total firms, per industry (U.S. Census Bureau, 2011a).
Independent variables	
*CR4**	Concentration Ratio for 4 largest industry firms; total sales by firms divided by total industry sales (U.S. Census Bureau, 2007a).
*CR8**	Concentration Ratio for 8 largest industry firms; total sales by firms divided by total industry sales (U.S. Census Bureau, 2007a).
*HH_Index**	Herfindahl-Hirschman Index (U.S. Department of Justice, 2015); sum of squared firms' market shares per industry (U.S. Census Bureau, 2007a).
*Birth_Rate***	Firms entering the market in a given year (age = 0) divided by total industry firms (U.S. Census Bureau, 2012b).
*Change_Rate***	Net flow (to and from an industry) of firms divided by total industry firms (U.S. Census Bureau, 2012b).
Control variables	
Firm_Age	Firms aged 5 years and younger divided by total firms (Ouimet, 2014), per industry (U.S. Census Bureau, 2012a).
Firm_Size	Amount of SMEs (Small- and Medium-sized Enterprises; Storey, 1994) divided by total industry firms (U.S. Census Bureau, 2012a).
Human_Cap	Firms owned by entrepreneurs with university degree divided by total industry firms (U.S. Census Bureau, 2007b).

R&D	R&D funds per industry divided by total R&D funds (U.S. Census Bureau, 2011a).
Indfix_Non_Suit	Dummy variable representing industries lacking innovation-suiting conditions (Andes, 2010; Boroush, 2010). Additional to collected data
Indfix_Suit	Dummy variable representing industries containing innovation-suiting conditions (Andes, 2010; Boroush, 2010). Additional to collected data
DY08	Dummy variable representing 2008, additional to collected data
DY09	Dummy variable representing 2009, additional to collected data
DY10	Dummy variable representing 2010, additional to collected data
DY11	Dummy variable representing 2011, additional to collected data

*: Tested as best-fitting value for market concentration (see further).
**: Tested as best-fitting value for market dynamics (see further).

The 2007 NAICS industry classification, or North American Industry Classification System, categorizes the data in 74 industries (see appendix A). This system splits all industries into manufacturing and non-manufacturing industries at the highest level and subdivides the data of the 74 included industries into up to six levels, represented by 6 digits (1 digit represents *All Industries* and is the highest aggregation, 6 digits for example represents *Military armored vehicle, tank and tank component* with the NAICS number of 336992, which is the most extensive subdivision). The NAICS system is the standard for classifying businesses for analyzing, collecting and publishing statistical data on the US business economy as used by federal statistics agencies (U.S. Census Bureau, 2007c).

A relatively large part of the data collect is data on manufacturing industries, 45 of the 75 industries for which data is collected. Not only because classification of manufacturing industries in general is more extensive, but also because this data is better available; collecting manufacturing data has been a component of the data collected by the U.S. government for a longer period than for other industries.

Data availability varies between industries as well, although it goes without saying that data is less available for 5- and 6-digit industries. Besides this, to for instance aircraft and military vehicle manufacturing secrecy laws are of effect, so data for these industries is classified. We have excluded industries missing a lot of data from the analysis. In order to still analyze a strong and extensive dataset, data is collected for four consecutive years (2008-2011), resulting in a more reliable dataset.

Innovation Data

The BRDIS survey yields the innovation data by inquiring companies to their share of significantly improved products or processes. This concept is described as "*the market introduction of a new or significantly improved good or service with respect to its capabilities, user friendliness, component, or* *sub-systems*" regarding product innovations and "*the implementation of a new or significantly improved production process, distribution method, or support activity for (your) goods or services*" regarding process innovation (U.S. Census Bureau, 2011b, p. 8-9). For both types of innovations, this applies to innovations that are new to the company, but not to the market and to innovations that are originally developed by the company. The survey requests to leave out *"simple resale of new goods purchased from other companies and changes of a solely aesthetic nature"* (U.S. Census Bureau, 2011b, p. 8) and asks firms for both new/improved goods and services whether or not competitors had marketed the innovation before. As the survey focusses on unique (new) goods and services, it excludes these goods.

The data is quite recent and there appears to be no published research using the data yet, which makes it interesting to use it in analysis. The downside, however, is that the data has not been thoroughly assessed yet either (although the research in this thesis initiates this), which entails uncertainty with respect to data quality. For instance, a valid point towards '*significantly improved*' goods, services or processes is that it is a rather vague term.

Table 2 shows the descriptive statistics of the data. See appendix B for more industry specific data descriptions.

Table 2 - Descriptive Statistics

Variable	N	Mean	Median	Std. Dev.	Min	Max
Innov. Ratio	286	0,335	0,335	0,166	0,019	0,917
CR4	276	0,268	0,205	0,186	0,032	0,876
CR8	276	0,358	0,296	0,217	0,053	0,952
HH_Index	176	591,276	291,100	706,933	7,000	2876,100
Birth_Rate	248	0,083	0,072	0,033	0,029	0,187
Change_Rate	248	-0,014	-0,013	0,027	-0,215	0,080
Firm_Age	268	0,287	0,252	0,064	0,205	0,438
Firm_Size	248	0,799	0,826	0,139	0,207	0,988
Human_Cap	296	0,494	0,422	0,128	0,223	0,748
R&D	211	0,073	0,010	0,172	0,00009	1,000

3.2 - Methodology

In order to correctly analyze the data and study the hypotheses formulated, it is of importance to use the proper estimation techniques: since data collected is cross sectional and we scale variables as ratio or continuous variables, using ordinary least squares estimation method (OLS) is adequate. In order to test for conditionality of market structure and market dynamics, an interaction term containing these variables is included. Three dummy variables are included to control for the year effect of the four

years of data. Regarding the last analysis, dummy variables representing each industry in the dataset are included, which enables studying (high level) differences in innovation on the industry level. By including this analysis, we can provide more context to the size and direction of the interfering factors originating in industry characteristics apart from those included in our analysis.
With respect to the quality of data: multiple tests for linearity of relationships, independence of residuals, presence of heteroskedasticity and approximate normality of errors have been conducted. None of the test results indicated problems with respect to data quality (test results not included).

Mentioned by means of an asterisk in the table describing the data, we test two sets of independent variables for best-fitting the concepts of market concentration and market dynamics. We do this by performing partial regression estimations testing the (single and combined) relationship of concentration and dynamics variables on innovation. The variable showing to be most significantly related to innovation is subsequently included as '*best fit*' for market concentration and dynamics.

Of importance are dummy variables *Indfix_Suit* and *Indfix_Non_Suit*, which control for the effect of favorable or unfavorable industry conditions towards innovation. These conditions are factors making an industry more likely to be innovative than others (in other words, a 'breeding ground' for innovation), apart from the factors already captured by other model variables, like entrepreneurship. An example of such a factor is technological opportunity, which the literature frequently mentions. Although data availability limits us to include relatively high level variables to correct for the industry effect (no possibility of including industry fixed effects), excluding these variables from analysis means disregarding its possible biasing effect entirely. Therefore, *Indfix_Suit* and *Indfix_Non_Suit* are included, correcting for respectively exceptionally innovative industries and industries characterized by exceptionally low innovative outputs. Appropriate industries are sourcing from Andes (2010) and Boroush (2010).

3.3 – Regression Equations

We estimate multiple regression equations in order to test the hypotheses formulated. First, we test which variables capture market structure and market dynamics best, since the dataset contains multiple variables for both concepts. We include the best-fitting variables in the main model and estimate two main model equations, excluding and including industry fixed effects. All equations estimated are provided below.

Market Concentration Best-Fit

Variables measuring market concentration in terms of firms' sales share (concentration ratios) and by summing squared market shares (Herfindahl-Hirschman Index) provide proxies for market concentration. Testing these proxies by means of the equations below results in the best-fitting variable, which we include in the main model analysis.

(1A) $\text{Innov\_Ratio}_i = \alpha + \beta_1 \textit{CR4} + \beta_2 \textit{CR8} + \beta_3 \textit{HH\_Index} + \beta_4 \textit{DY09} + \beta_5 \textit{DY10} + \beta_6 \textit{DY11} + \varepsilon$

(1B) $\text{Innov\_Ratio}_i = \alpha + \beta_1 \textit{CR4} + \beta_2 \textit{CR8} + \beta_4 \textit{DY09} + \beta_5 \textit{DY10} + \beta_6 \textit{DY11} + \varepsilon$

Market Dynamics Best-Fit

Secondly, we analyze market dynamics best-fit by testing *Birth_Rate* and *Change_Rate*. Both proxy market dynamics, but since *Change_Rate* also comprises firms leaving an industry, it is likely to better capture market dynamics. Equation (2B) includes variable *Firm_Age*, as *Birth_Rate* shows to suffer from interference by entrepreneurial factors. Besides this, we correct for industry effects.

(2A) $\text{Innov\_Ratio}_i = \alpha + \beta_1 \textit{Birth\_Rate} + \beta_2 \textit{Change\_Rate} + \beta_3 \textit{Indfix\_Non\_Suit} + \beta_4 \textit{Indfix\_Suit} + \beta_5 \textit{DY09} + \beta_6 \textit{DY10} + \beta_7 \textit{DY11} + \varepsilon$

(2B) $\text{Innov\_Ratio}_i = \alpha + \beta_1 \textit{Firm Age} + \beta_2 \textit{Birth\_Rate} + \beta_3 \textit{Change\_Rate} + \beta_4 \textit{Indfix\_Non\_Suit} + \beta_5 \textit{Indfix\_Suit} + \beta_6 \textit{DY09} + \beta_7 \textit{DY10} + \beta_8 \textit{DY11} + \varepsilon$

Main model: market structure, market dynamics and innovation

After selecting the best variables for market structure and market dynamics, we estimate the main model. Estimating the model provides results in threefold: a) evidence on the relationship between market concentration, market dynamics and the new innovation data, b) insights on the conditional relationship of concentration and dynamics on innovation and c) the impact of intervening factors, specifically industry effects. Following the literature, four control variables are included: *Human_Cap*, *Firm_Size*, *Firm_Age* and *R&D*. *R&D* controls for innovative input (funds), *Human_Cap* controls for industry educational level (a proxy of labor skill level), the other two proxy size and entrepreneurial effects. This results in estimating the two equations below, one excluding and one including industry effects.

(3A) $\text{Innov\_Ratio}_i = \alpha + \beta_1 \textit{Human\_Cap} + \beta_2 \textit{CR8} + \beta_3 \textit{Firm\_Size} + \beta_4 \textit{Firm\_Age} + \beta_5 \textit{R\_D} + \beta_6 \textit{Birth\_Rate} + \beta_7 \textit{Change\_Rate} + \beta_8 \textit{CR8*Change\_Rate} + \beta_9 \textit{DY09} + \beta_{10} \textit{DY10} + \beta_{11} \textit{DY11} + \varepsilon$

(3B) $Innov\_Ratio_i = \alpha + \beta_1 Human\_Cap + \beta_2 CR8 + \beta_3 Firm\_Size + \beta_4 Firm\_Age + \beta_5 R\_D + \beta_6 Birth\_Rate + \beta_7 Change\_Rate + \beta_8 CR8*Change\_Rate + \beta_9 Indfix\_Non\_Suit + \beta_{10} Indfix\_Suit + \beta_{11} DY09 + \beta_{12} DY10 + \beta_{13} DY11 + \varepsilon$

Innovative Industries

Further analysis on the confounding effect of industry characteristics is conducted via equation (4), regressing all industry dummy variables on the innovation ratio. As a result, we can identify size and direction of the effect on innovation for specific industry groups.

(4) $Innov\_Ratio_i = \alpha + \beta_1 Dum\_Construction + \beta_2 Dum\_Finance + \beta_3 Dum\_Health + \beta_4 Dum\_Information + \beta_5 Dum\_Manufacturing + \beta_6 Dum\_Mining + \beta_7 Dum\_Real\_Estate + \beta_8 Dum\_Service + \beta_9 Dum\_Telecom + \beta_{10} Dum\_Trade + \beta_{11} Dum\_Transport + \beta_{12} Dum\_Utilities + \beta_{13} DY09 + \beta_{14} DY10 + \beta_{15} DY11 + \varepsilon$

4. Results

4.1 – Best-Fit: Market Concentration and Market Dynamics

Market Concentration

Three variables representing the degree to which an industry is concentrated means analyzing the same effect threefold. Therefore, the first equation yields the variable strongest related to innovation. Estimating equations (1A) and (1B), for outcomes see Table A-1 (Appendix C), shows insignificance of all variables when including the *Herfindahl-Hirschman Index*. Possibly due to inferior data quality (presence of outliers, non-normality of residuals and missing values) this variable biases findings. Leaving this variable out yields proper results and shows that *CR8*, the concentration ratio for the top 8 industry firms, is best-fit as it is significant at the 5% level. Therefore, *CR8* is included in the main model analysis.

Market Dynamics

The same applies to the two variables capturing market dynamics: *Birth_Rate* and *Change_Rate*. See Table A-2 (Appendix C) for estimation output of equations (2A) and (2B). We find significance at the 1% level for *Birth_Rate* excluding *Firm_Age*, but only significance at the 10% level when the proxy for entrepreneurship is included. *Change_Rate*, however, becomes significant at the 1% level (as is the case for *Firm_Age* and *Indfix_Suit*). Although *Change_Rate* is best-fit regarding market dynamics, we can still find some evidence of a significant effect of *Birth_Rate*. Hence, both variables are included in the main model.

4.2 – Main Model: concentration, dynamics and innovation

Now, we estimate equations (3A) and (3B) to analyze our main model. First, we look at model (3A), excluding industry effects. Estimation outcomes are shown in Table 3 below.

Looking at the three control variables included, we find significant effects of *Firm_Age* (1% level) and evidence for *Human_Cap*. *Firm_Size* and *R&D* turn out to be insignificant. *Firm Age* shows to be of negative effect on innovation: if an additional 1% of industry firms are 0 to 5 years old, the innovation ratio is decreased by 1,49%. A 1% increase in *Human Capital* increases the innovation ratio by 0,22%, indicating that a higher percentage of business owners holding a university degree is of positive influence on innovation, besides being of significance as a control variable. We do not observe a significant effect on innovation for market dynamics through *Birth_Rate*.

Market concentration is found to have a significant effect at the 1% level and its individual effect can be explained as a 1% increase in the concentration ratio increasing the Innovation Ratio by 0,2%, providing evidence that a higher market concentration stimulates innovative activity. A net firm change of 1%, results in a stimulated *Innovation Ratio* by 3,68%, which demonstrates that a highly dynamic industry in terms of firm flow is positive for innovation. These findings, however, concern the *individual* effects of market concentration and market dynamics; we will proceed to discuss the conditional (interacted) effects of concentration and dynamics on innovation.

Conditional effects

Findings on conditionality are interesting: included as an interaction variable, the effects of concentration and firm dynamics have a combined, interdependent effect on the innovation ratio. The interaction term shows that the effect of the concentration ratio differs for different values of firm change rate (and vice versa). The total effect of both variables is calculated by summing separate and interacted effects (mathematically: ($\beta_6 + \beta_7$**CR8)*Change_Rate*). If we fix the amount of the largest 8 firms' sales (concentration ratio) at 50%, this results in a firm change rate effect of *(3.7 – 8.5*0.5) = -0,6%*, multiplied by the change in *Change_Rate*. So, depending on the market power of the largest 8 firms in the industry, an increasing flow of firms could actually be of negative influence on industry innovativeness. Besides this, evidently, not only the current level of *CR8* is affecting the effect of *Change_Rate* on the innovation ratio, also an increase or decrease in this ratio affects the (total) effect of *Change_Rate*. In the case that the concentration ratio is very small, when there is not much market power, the effect of an increasing amount of firms flowing from (and to) the market would be positive. Note that this is the case when a market moves from a monopoly or oligopoly to a perfectly competitive market (containing a high amount of supplying firms) and per firm sales shares decrease.

From the perspective of the concentration ratio, it is also possible that a high level of market power accompanied by a low change in industry firm volume positively affects the introduction of innovative products and processes. The total effect of the concentration ratio is ($\beta_2 + \beta_7$**Change_Rate)*CR8*, which yields a total effect of *(0.2 – 8.5*0.01) = +0.12%* increase of the innovation ratio when setting the total change in industry firms as low as 1% (multiplied by the increase in concentration ratio, if any). Again, an increase or decrease in *Change_Rate* affects the impact of the concentration ratio, not just its level at a static moment.

It is clear that interacting market concentration with market dynamics only yields a positive effect on the innovation ratio in the case that one of the two variables has a low value. So, a high value of both *CR8* and *Change_Rate* results in a market structure not stimulating innovation, possibly even yielding an unstable market structure in general. As a low value of market concentration indicates an industry with a high level of small firms (suppliers) and competition; so does a low level of market dynamics indicate a relatively closed industry (for example due to entry barriers, like high costs to set up a company) dominated by a select amount of large, powerful firms. Both scenarios appear to be a fertile ground for innovation.

Interference: Industry Effects

Although equation (3A) found a positive and significant effect of both individual effects and interacted effects, this only holds in the case when we exclude industry effects. Estimating equation (3B), shown in Table 3, yields different results. To start with, we find that the industry effect of innovation-suitable industries (*Indfix_Suit*) is significant at the 1% level and interferes with results found in the previous section. As a result of including industry effects, the conditional effect of market concentration and market dynamics not only decreases in size, but turns insignificant as well. Individual effects remain significant, except regarding *Human_Cap*; for which we no longer find evidence of a significant effect. Regarding variables' effect size, we find that including industry effects affects coefficients size with some ambiguity: effect size (and significance) of *CR8* increases, but *Firm_Age* and *Change_Rate* now have a lower coefficient. In other words: a 1% increase in the concentration ratio now increases the innovation ratio with 0,23%; the same increase in the firm age ratio yields a 0,85% decrease in innovation and the effect of market firm dynamics on innovation is reduced to a 2,02% increase of innovation for a 1% higher net firm flow. Clearly, we find empirical evidence for presence of interference by (high level) industry characteristics, since *Indfix_Suit* is significant at the 1% level. This interference, however, is not enough to negate all other effects found, since market concentration, firm age and net firm flow remain significant.

4.3 – Innovative Industries

Innovation Accelerators

The results section concludes with general industry impact on innovation. Estimating equation (4) yields the outcomes provided in Table 4. For two of the twelve industry clusters we find evidence supporting positive impact: the information and manufacturing industries. Outcomes show great insignificance with respect to innovation for traditionally conservative and labor-intensive construction and mining industries. Interpreting the dummy variables, the results are that firms part of the information industry cause the innovation ratio to be 0,20% higher relative to firms not part of this industry cluster. The same applies to the manufacturing industry, which amounts 0,24% more to innovation than firms outside these industries. Note though that significance of the manufacturing industry might partly be driven by the large extent of which manufacturing data is part of the dataset (leaving the manufacturing industries out, however, yields inconsistent results). This however, we cannot change this other than by using a different database.

Innovation Obstructors

There is little evidence of specific industries significantly decreasing innovation: although construction and mining industries have a negative coefficient size, results show none of these effects to be significant. It might be possible that significance is found in lower level industries (4- to 6-digit industries), but since analyzing this is not of direct relevance to the scope of our analysis, we will leave this be.

Table 3	Market Structure and Innovation – Main Models	
Independent Variable	**Innov_Ratio**	
Model (equation)	**3A**	**3B**
Constant	0,522***	**0,414*** **
	(0,145)	**(0,126)**
Human_Cap	0,220**	**0,125**
	(0,101)	**(0,087)**
CR8	0,203**	**0,232** **
	(0,080)	**(0,070)**
Firm_Size	0,040	**0,082**
	(0,106)	**(0,090)**
Firm_Age	-1,493***	**-0,848** **
	(0,328)	**(0,295)**
R_D	-0,027	**-0,036**
	(0,047)	**(0,040)**
Birth_Rate	0,639	**-0,812**
	(0,625)	**(0,566)**
Change_Rate	3,684***	**2,018** **
	(1,080)	**(0,947)**
CR8*Change_Rate	-8,516**	**-3,441**
	(2,710)	**(2,403)**
Indfix_Non_Suit		**-0,004**
		(0,019)
Indfix_Suit		**0,186*** **
		(0,025)
DY09	0,025	**0,018**
	(0,026)	**(0,022)**
DY10	0,009	**0,017**
	(0,027)	**(0,023)**
DY11	-0,033	**-0,014**
	(0,029)	**(0,025)**
R^2	0,433	**0,596**
Adjusted R^2	0,391	**0,560**
Observations	160	**160**

Standard Errors are between brackets, * is significant at 10%, ** is significant at 5%, *** is significant at 1%.

Table 4	Innovative Industries
Independent Variable	**Innov_Ratio**
Constant	0,121
	(0,074)
ID* - Construction	-0,070
	(0,111)
ID – Finance	0,134
	(0,102)
ID – Health	0,004
	(0,102)
ID – Information	0,200**
	(0,077)
ID – Manufacturing	0,239***
	(0,073)
ID – Mining	-0,071
	(0,102)
ID – Real Estate	0,020
	(0,086)
ID – Service	0,103
	(0,076)
ID – Trade	0,036
	(0,086)
ID - Transport	0,035
	(0,102)
DY09	0,037
	(0,024)
DY10	0,050**
	(0,024)
DY11	0,033
	(0,025)
R^2	0,277
Adjusted R^2	0,242
Observations	285

*: ID indicates industry dummy, due to perfect collinearity 1 industry dummy is left out: Utilities Industry (randomized)
Standard Errors are between brackets, * is significant at 10%, ** is significant at 5%, *** is significant at 1%.

5. Discussion

5.1 - Discussion

In what way do the results as described above contribute to the already massive amount of research on market structure and innovation? We can show validity of the research design applied by viewing the results next to theory and literature. In the same fashion as we found the research gap to be twofold, are the implications of the results dual.

Although past research found ambiguity of the relationship between market structure and innovation, our analysis of new innovation data supports the literature finding an existing and positive relationship, providing evidence supporting hypothesis 1. Both in the cases including and excluding interference of industry effects we find evidence for the relationship, demonstrating the value of the new innovation data. Moreover, in replicating previous research, our analysis of new innovation data also shows the importance of including control and interference variables, as they affect effect sizes. The inclusion of quite some control variables, of which the most turned out to be insignificant, substantiates the robustness of the positive relationship found between innovation and market structure.

So, be it preliminary, the assessment of the new innovation data shows that the data is well able to both indicate and capture the relationship between market structure and innovation.

Secondly, there are consequences to the results found on conditionality of market concentration and market dynamics. We find that certain levels of market concentration and market dynamics lead to conditions stimulating innovation, thereby rejecting hypothesis 2, as opposing values for concentration and dynamics appear to benefit innovation. However, this only holds in the case of excluded industry effects. Still, these results are directly in line with Schumpeter's *Mark I* and *II* models.

Besides this, the findings also support the literature stating that the relationship between market structure and innovation is not static, but dynamic in nature. The outcome adds the perspective of stability in market conditions to the debate on Schumpeterian innovation, although our analysis also shows that inclusion of industry effects disproves the presence of conditionality. This, together with the observed impact of control variables, implies support for hypothesis 3 and 'overrules' evidence regarding hypothesis 2. Findings are clear enough to show that when industry effects are incorporated, we cannot find evidence for the interacted effect anymore; results on industry specific analysis substantiate this by showing differences in stimulus of industry innovation. Although the variable included for interference of industry effects is a rather simple one, it is well able to point out that differences between industries on behalf of innovation stimulus negate the conditional effect. This could indicate that more (other) industry specific characteristics influence the way in which market

concentration and market dynamics jointly affect innovation. These characteristics and their impact on the relationship of market structure and innovation, however, are topics for further research.
In the end, evidence on hypothesis 3 is present but inconsistent; on the one hand industry effects increase the impact of both factors of interest and control variables on innovation. But on the other hand, only the control variable for entrepreneurial effects, firm age, affects innovation downward.

Next, we regard limitations of our research. A limitation to the analysis conducted is the fact that we are not able to show and correct for endogeneity, of which past research finds (equivocal) evidence. Including issues of endogeneity also requires a different methodology, for instance using instrumental variables in 2SLS analysis. Besides this, the scope of the thesis limits the analysis to include only a confined amount of variables in assessment. Understanding the 'bigger picture', or complete equilibrium, requires incorporation of all relevant variables. Therefore, we must regard results as providing evidence on presence and magnitude of relationships, never on causality of these relationships. Ultimately, as Cohen and Levin (1989) state: market concentration cannot be considered as an independent driver of innovation. Another limitation lies in the variable used to control for industry effects; this variable is very general as it solely controls for innovation suiting and non-suiting industries by means of dummy variables. Using more specific industry control variables, such as per industry technological opportunity or technology growth rates, would result in a higher quality variable to assess industry interference.
In the end, the disproval of the conditional relationship by means of adding industry effects as we perform the analysis is not a definitive answer. Hence including more specific variables on industry effects as stated above certainly is an opportunity for future research. Besides this, our analysis includes data for a rather limited period of time (four years). Extending the timeframe or performing a time series analysis could increase insights in the presence of the conditional relationship and its development over time. In line with this, I also recommend extending analysis by studying geographical units besides the U.S. industries, with the same purpose of obtaining a clearer view on the conditional relationship.
Finally, the new innovation data offers possibilities in research to come, especially when more thoroughly tested for quality and assessed with other sources of data. Still, by continuing research with this data, more light can be shed on the complex relation between market structure and innovation.

5.2 - Conclusion

Past research on market structure and innovation shows a complex relationship and lack of uniformity in empirical evidence, next to measurement problems regarding innovation. It finds evidence supporting and evidence disproving the relationship, as well as showing the need for research with better data and more insights of all factors at play. We address both of these issues by analyzing new innovation data for U.S. industries; reproducing past research on the topic and studying the conditional relationship between two important market structure factors: market concentration and market dynamics. Since both theory and literature address the interference of factors entrepreneurship, size, educational level, industry effects and more; proxies for these factors are included for control and studied for their impact on market structure and innovation. Analyzing aggregated U.S. industry data for the period of 2008-2011, we find a positive individual effect of market concentration and market dynamics, both when including and when excluding industry effects. Controlling for entrepreneurship in terms of firm age shows a significant, negative effect on innovation. We find a significant effect regarding the conditional relationship, but this effect is solely positive in the case that either market concentration or market dynamics has a high value and the other a low value. However, this finding is only significant when industry effects are excluded, showing interference of industry effects and the importance of including these in analysis. Therefore, answering the research question *"What empirical insights can analysis of recent innovation data add to the debate on Schumpeterian innovation determinants and conditionality?"* we can argue that despite the existing body of research new insights can still be gained. By studying new data and addressing gaps in research as done in this thesis, findings such as obtained in our analysis can still contribute to the Schumpeterian debate. Opportunities for future research are also many, as due to a limited scope issues of endogeneity and suchlike have not been taken into account. Still, with every new research on the topic, understanding of the complex relationship between market structure and innovation grows.

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Appendices

Appendix A – NAICS Industries

Name, level and NAICS number of all industries included in analysis

Industry	Level	NAICS Number
All Industries	**1**	**21–23, 31–33, 42–81**
Manufacturing Industries	**2**	**31–33**
Food	3	311
Beverage and tobacco products	3	312
Textile, apparel, and leather products	3	313–316
Wood products	3	321
Paper	3	322
Printing and related support activities	3	323
Petroleum and coal products	3	324
Chemicals	3	325
Basic chemicals	4	3251
Resin, synthetic rubber, and artificial synthetic fibers and filaments	4	3252
Pesticide, fertilizer, and other agricultural chemical	4	3253
Pharmaceuticals and medicines	4	3254
Soap, cleaning compound, and toilet preparation	4	3256
Paint, coating, adhesive, and other chemicals	4	3255, 3259
Plastics and rubber products	3	326
Nonmetallic mineral products	3	327
Primary metals	3	331
Fabricated metal products	3	332
Machinery	3	333
Agricultural implement	5	33311
Semiconductor machinery	6	333295
Engine, turbine, and power transmission equipment	4	3336
Other machinery	4	3339
Computer and electronic products	3	334
Communications equipment	4	3342
Semiconductor and other electronic components	4	3344
Navigational, measuring, electromedical, and control instruments	4	3345
Electromedical, electrotherapeutic, and irradiation apparatus	6	334510, 334517
Search, detection, navigation, guidance, aeronautical, and nautical systems and instruments	6	334511
Other measuring and controlling device	4	other 3345
Other computer and electronic products	3	other 334
Electrical equipment, appliances, and components	3	335
Transportation equipment	3	336
Motor vehicles, bodies, trailers, and parts	4	3361, 3362, 3363
Aerospace products and parts	4	3364
Aircraft, aircraft engine, and aircraft parts	6	336411–13

Guided missile, space vehicle, and related parts	6	336414–15, 336419
Military armored vehicle, tank, and tank component	6	336992
Other transportation equipment	4	3369
Furniture and related products	3	337
Miscellaneous manufacturing	3	339
Medical equipment and supplies	4	3391
Other miscellaneous manufacturing	4	3399
Nonmanufacturing Industries	**2**	**21–23, 42–81**
Mining, extraction, and support activities	**2**	**21**
Utilities	**2**	**22**
Construction	**2**	**23**
Wholesale trade	**2**	**42**
Retail Trade	**2**	**44-45**
Electronic shopping and electronic auctions	6	454111–12
Transportation and warehousing	**2**	**48–49**
Information	**2**	**51**
Publishing	3	511
Newspaper, periodical, book, and directory publishers	4	5111
Software publishers	4	5112
Telecommunications	3	517
Data processing, hosting, and related services	3	518
Other information	3	519
Finance and insurance	**2**	**52**
Real estate and rental and leasing	**2**	**53**
Lessors of nonfinancial intangible assets (except copyrighted works)	3	533
Other real estate and rental and leasing	2	other 53
Professional, scientific, and technical services	**2**	**54**
Architectural, engineering, and related services	4	5413
Computer systems design and related services	4	5415
Scientific research and development services	4	5417
Biotechnology research and development	6	541711
Physical, engineering, and life sciences (except biotechnology) research and development	6	541712
Social sciences and humanities research and development	6	541720
Other professional, scientific, and technical services	4	5419
Health care services	**3**	**621–23**
Other nonmanufacturing	**2-3**	**55–56, 624, 71–72, 81**

Appendix B – Data Description

Minimum, maximum and average values for model variables

Innov_Ratio	Industry	NAICS	Value (%)	Year
Minimum	Mining, Extraction and Support Activities	21	**1,9%**	2008
Maximum	Guided Missile, Space Vehicle and related parts	33641	**91,7%**	2010
Average	N.A.	N.A.	**33,5%**	N.A.

Firm_Age	Industry	NAICS	Value (%)	Year
Minimum	Construction	23	**20,5%**	2011
Maximum	Retail Trade	44-45	**43,8%**	2008
Average	N.A.	N.A.	**28,7%**	N.A.

Firm_Size	Industry	NAICS	Value (%)	Year
Minimum	Telecommunications	517	**20,7%**	2008
Maximum	Construction	23	**98,8%**	2008
Average	N.A.	N.A.	**79,9%**	N.A.

Concentration Ratios	Industry	NAICS	Value (%)	Year
Minimum (4)	Fabricated Metal Products	332	**3,2%**	2008
Maximum (4)	Guided Missile, Space Vehicle and related parts	33641	**87,6%**	2008
Average (4)	N.A.	N.A.	**26,8%**	N.A.
Minimum (8)	Fabricated Metal Products	332	**5,3%**	2008
Maximum (8)	Guided missile, space vehicle and related parts	33641	**95,2%**	2008
Average (8)	N.A.	N.A.	**35,8%**	N.A.

HH_Index	Industry	NAICS	Value	Year
Minimum	Fabricated Metal Products	332	**7,00**	2008
Maximum	Semiconductor Machinery	333295	**2876,10***	2008
Average	N.A.	N.A.	**591,28**	N.A.

*: The maximum value collected for HHI is not even near the maximum of 10.000 points. The data on the larger part of the industries show moderately of lowly concentrated markets.

Human_Cap	Industry	NAICS	Value (%)	Year

Minimum	Transportation and Warehousing	48-49	**22,3%**	2008
Maximum	Professional, Scientific and Technical Services	54	**74,8%**	2008
Average	N.A.	N.A.	**49,4%**	N.A.

Birth_Rate	Industry	NAICS	Value (%)	Year
Minimum	Paper (Manufacturing)	322	**2,9%**	2009
Maximum	Information (Other)	519	**18,7%**	2011
Average	N.A.	N.A.	**8,3%**	N.A.

Change_Rate	Industry	NAICS	Value (%)	Year
Minimum	Data Processing, Hosting and Related Services	518	**-21,5%***	2009
Maximum	Beverage and Tobacco Products	312	**8,0%**	2011
Average	N.A.	N.A.	**-1,4%**	N.A.

*: interesting descriptive, this huge change in firm amount over the course of 2008-2009 is most likely related to the economic crisis (Foote Partners LLC, 2012), however; why would this specific (IT-related) industry have the largest decrease in firms?

R_D	Industry	NAICS	Value (%)	Year
Minimum	Military armored vehicle, tank, and tank components	336992	**0,009%**	2011
Maximum	Total Manufacturing Industries	31-33	**73,2%**	2010
Average	N.A.	N.A.	**7,3%**	N.A.

Appendix C – Regression Outputs

Regression output for supporting evidence

Table A-1	Market Structure Best-Fit	
Independent Variable	**Innov_Ratio**	
Model (equation)	**1A**	**1B**
Constant	0,223***	0,181***
	(0,031)	(0,024)
CR4	0,241	-0,124
	(0,400)	(0,249)
CR8	0,215	0,486**
	(0,262)	
HH_Index	-0,00004	
	0,00005	(0,214)
DY09	0,031	0,028
	(0,288)	(0,025)
DY10	0,066	0,043*
	(0,288)	(0,025)
DY11	0,030	0,026
	(0,029)	(0,025)
R^2	0,240	0,260
Adjusted R^2	0,212	0,246
Observations	170	267

Standard Errors are between brackets, * is significant at 10%, ** is significant at 5%, *** is significant at 1%.

Table A-2	Market Dynamics Best-Fit	
Independent Variable	**Innov_Ratio**	
Model (equation)	**2A**	**2B**
Constant	0,391***	0,702***
	(0,031)	(0,043)
Firm_Age		-1,208***
		(0,161)
Birth_Rate	-1,345***	-0,655*
	(0,285)	(0,337)
Change_Rate	0,432	1,707***
	(0,362)	(0,369)
Indfix_Non_Suit	-0,024	-0,009
	(0,021)	(0,017)
Indfix_Suit	0,226***	0,205***
	(0,027)	(0,023)
DY09	0,023	0,033
	(0,025)	(0,021)
DY10	0,020	0,009
	(0,024)	(0,021)
DY11	0,029	-0,022
	(0,024)	(0,021)
R^2	0,289	0,519
Adjusted R^2	0,267	0,500
Observations	242	214

Standard Errors are between brackets, * is significant at 10%, ** is significant at 5%, *** is significant at 1%.