



LUND UNIVERSITY
School of Economics and Management

Innovation in Times of Crisis

An Analysis of Firm Performance During the Financial Crisis

Master's Thesis 2015

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This thesis examines how innovation affects firm performance in the United States during the financial crisis in 2008. A difference-in-difference estimation combined with Coarsened Exact Matching is applied on a panel data set of 4,928 U.S. firms between 2004 and 2011. Two opposing theoretical frameworks concerning the outcome are used to state hypotheses regarding if innovative firms perform better or worse than non-innovative firms after the crisis. The result indicates that innovative firms perform better and the result is supported by the theories of market power, dynamic capabilities and absorptive captivity. The result encourages firms to engage in innovation to enhance firm performance and to become more adaptive to changes in the market.

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1. Introduction

Governments all over the world are promoting innovation as a key to sustained economic growth, meeting global challenges and enhancing firm performance (OECD, 2015). An innovation is generally defined as being a new product, idea or process (Maranville, 1992). National innovation strategies are established in order to find the next innovation and the pursuit of innovativeness is a vital part in the United States, a world leading innovative economy (Mach and Wolken, 2012).

In 2008 the world was hit by the financial crisis, which caused economic turmoil and a great deal of uncertainty in the market. In the U.S. firms experienced a decrease in market demand and industries struggled to avoid bankruptcy. U.S. firms also experienced a decrease in access to credits, a factor closely linked to firm performance (Mills and McCarthy, 2014). It is empirically supported that financial constraints are stronger for innovative firms compared to other firms and that the effect was especially strong during the financial crisis in 2008. The reason is that innovative firms' business models are argued to be riskier and in times of financial turmoil investors prefer "safer" investments (Angilella, 2015; Wehringer, 2014). This is also supported by economic theory, and Allegrezza (2013) and Freel (2006) argue that asymmetric information between entrepreneurs and investors discourage investments in innovative firms, which cause a negative relationship between innovation and firm performance during economic crises.

However, the economic theories of dynamic capability and absorptive capacity argue that the opposite relationship is true, and that innovativeness is instead desirable in times of economic crisis and has a positive relationship with firm performance. The reason is that innovative firms are more robust to market changes and can easier absorb new information and adapt to changes in the market. Previous research is clearly ambiguous if it is desirable to be innovative during economic crises and the purpose of this thesis is to assess the impact of innovativeness on firm performance during the crisis. Therefore, the research question to be answered is: "How did innovation affect firm performance in the United States during the financial crisis of 2008?"

This question is explored by a difference-in-difference method, which compare innovative and non-innovative firms during the time period 2004-2011 and the financial crisis in 2008 is used as a breaking point to see the effect of innovation on firm performance. Firm performance is approximated by return to assets and the estimation is performed on a longitudinal panel data survey of start up firms in the

U.S. The survey contains information from 4,928 firms that started in 2004 with annual follow up surveys until 2011, which makes a total of 39,434 observations in the dataset. The estimation is enhanced by the application of Coarsened Exact Matching, which is a non-parametric matching strategy that statistically selects and balances the comparison groups of innovative and non-innovative firms. This is done in order to obtain groups with similar covariate distribution, which enhance causal interpretation of the empirical analysis (King et al, 2010).

This thesis adds to the existing literature an empirical research on how firms' ability to innovate affect performance during the financial crisis in the U.S. This is something that has not been done before and the empirical strategy of applying a difference-in-difference method together with Coarsened Exact Matching provides a robust empirical estimation and an updated approach to causal interpretation.

1.1 Disposition

This study is structured as follows: In section 2 a review of previous studies in the field is presented. In section 3 the financial crisis and its impact on firms in the U.S. is outlined. In section 4 the data and method is presented. In section 6 the result is presented, followed by a discussion of the result. In the final section 7 conclusions from this study is presented.

2. Literature Review

The success, failure and performance of innovative firms are topics that have caught the attention of researches in recent years. Different estimation methods have been used to understand the economic mechanisms and the relationship between firm performance and innovation. A possible reason behind this increased interest is that governments have realized the importance of innovativeness in order to compete in the world market (Wehinger, 2014). Even though governments all over the world are supporting innovation, previous research results are ambiguous whether innovative firms are more successful than other firms, especially among small firms (Sidorkin and Srholec, 2012; Angiella and Mazzu, 2015).

Makkonen et al (2013) analyze how firm performance is affected by innovativeness through dynamic capabilities during the financial crisis in 2008. Their empirical strategy is based on structural equation modeling applied on a firm survey conducted in Finland in 2009. The result indicates that innovative firms perform better than non-innovative firms and that innovations give firms a competitive

advantage. Cefis and Marsilli (2011, 2012) study the Dutch manufacturing industry and in their research they find that firms' innovativeness and survival rate, which can be seen as an indicator of performance has a positive relationship. The authors argue that success in supporting innovation is highly correlated with performance. Other research is also in support of a positive link between innovativeness and firm performance. Rosenbusch et al (2011) applies a meta-analysis technique to aggregate prior research on innovation and performance for small and medium sized firms using 42 empirical studies and data from 21.270 firms. They find a positive effect of innovativeness on firm performance and apply different measurements of innovation. They find that measuring innovation as firms research expenditures has a stronger relationship with performance than using patents.

However, other studies argue that innovativeness instead has a negative effect on performance. Samuelsson and Davidsson, (2009) argue that this negative relationship is caused by innovative activities in general being riskier and more complicated business models, which are more likely to fail. Hyytinen et al (2015) measure innovation through the number of patent applications of a firm, and conclude that there is a negative association between innovation and startup firms' survival rates. The authors argue that the pursuing of innovations is not necessarily associated with increased firm performance during the early stages of firm development and may even complicate the start-up process (Hyytinen et al, 2015). Lee and Saamen (2013) study 12000 firms in the United Kingdom and use a simple difference-in-difference estimation to study how innovative firms are affected by the financial crisis in terms of access to credit. They find that small firms are less likely to get access to finance; which has a negative effect on firm performance. Angilella and Mazzu (2015) compare innovative and non-innovative small firms and the impact of the financial crisis. They use a sorting model and find that asymmetric information between the entrepreneur and investor may limit access to finance for innovative firms and decrease firm performance.

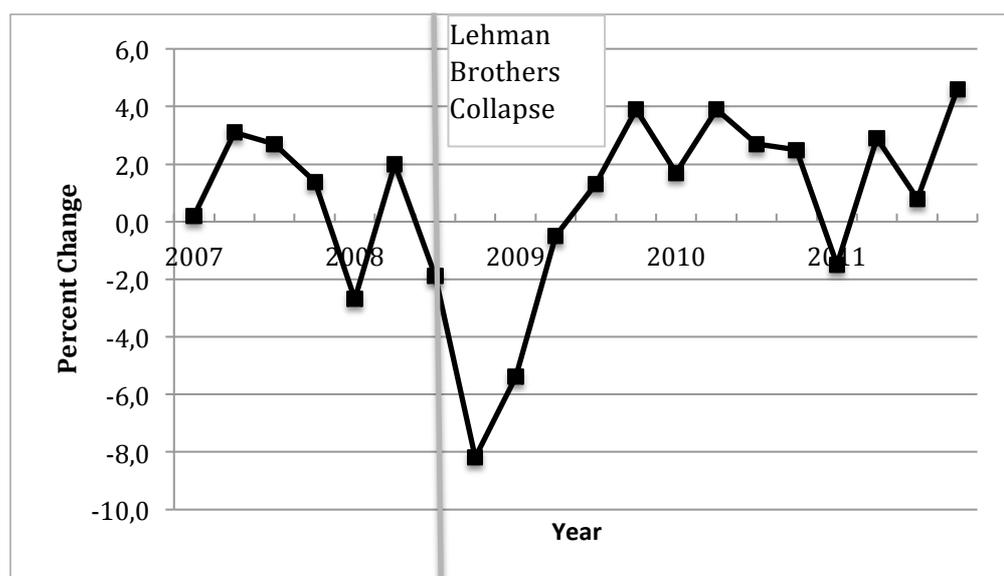
Consequently, previous research indicates that there are many possible approaches to study how innovativeness affects firms' performance during economic turmoil. As presented above the focus of previous research have primarily been on innovative firms' performance in normal economic times or on firms' access to credit. This study aims to fill a gap in previous literature by studying firms' performance before and after the financial crisis to see how innovativeness affect firm performance.

3. The Financial Crisis Impact on Firms in the U.S.

The financial crisis lasted between 2007 and 2009, and from the beginning it appeared to just be a small disruption in the financial system, but later on the crisis spread and would in the end have a significant impact on the world economy.

The crisis can in general be divided into two phases. The first phase started in August 2007 and was limited to the U.S. subprime residential mortgages. This is a small segment of the U.S. financial system and it experienced great losses as a result of decreasing housing prices in the U.S. The losses were in the beginning limited, but started to spread through out the economy as banks and owners of subprime securities and other house related assets started to lose money. In September 2008 the financial crisis entered a new phase as the investment bank Lehmann brothers entered bankruptcy on September the 15 as a result of having held large positions in subprime-linked securities. This event was followed by the collapse of the insurance firm AIG the day after and this was the beginning of a serve economic crisis (Mishkin, 2010; Wehinger, 2014). The crisis affected the U.S. economy and the firms' operating within it heavily through several different channels. In the third quarter of 2008 the GDP growth started to fall at a -1.3 annual percentage rate, followed by a decline of -5.4 percentage rate in December and -6.4 percentage in January 2009 shown in Figure 1. Which is, The worst economic contraction in the U.S in the last 70 years and similar economic development was reported globally and the world economic growth fell by -6.4 percent in the last quarter of 2008 (FRED, 2015).

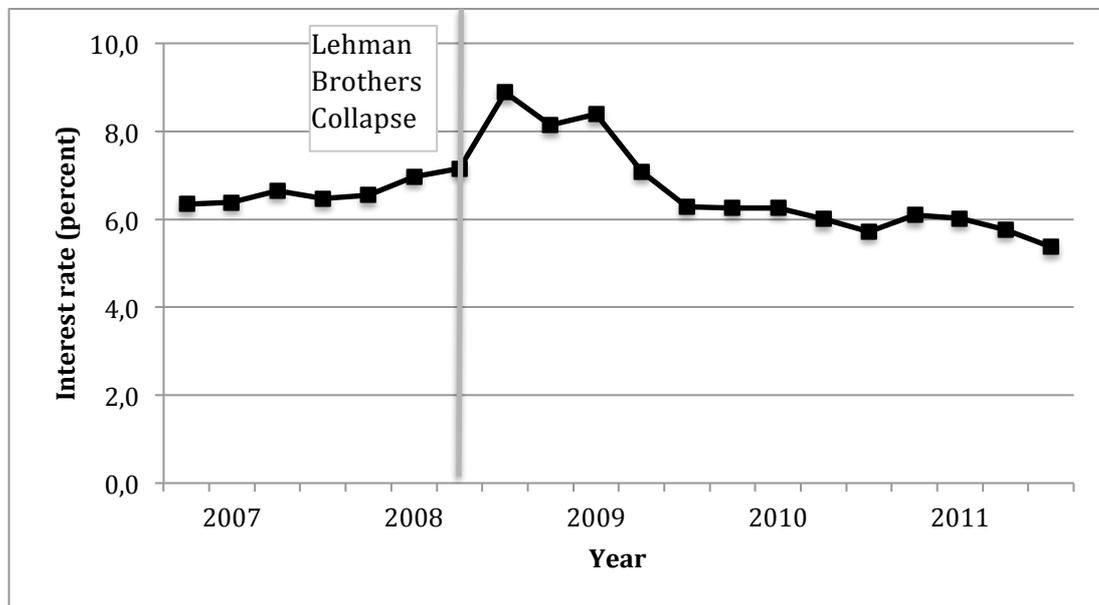
Figure 1. Percent Change of GDP, Quarterly, Seasonally Adjusted Annual Rate



Source: FRED, 2015

This economic development increased interest rates in the U.S. and the interested rate relevant to household and business purchase drastically increased as a result of the economic collapse. This interest rate had a negative effect on aggregated demand in the economy and the development of the BAA corporate bond rate is shown in Figure 2.

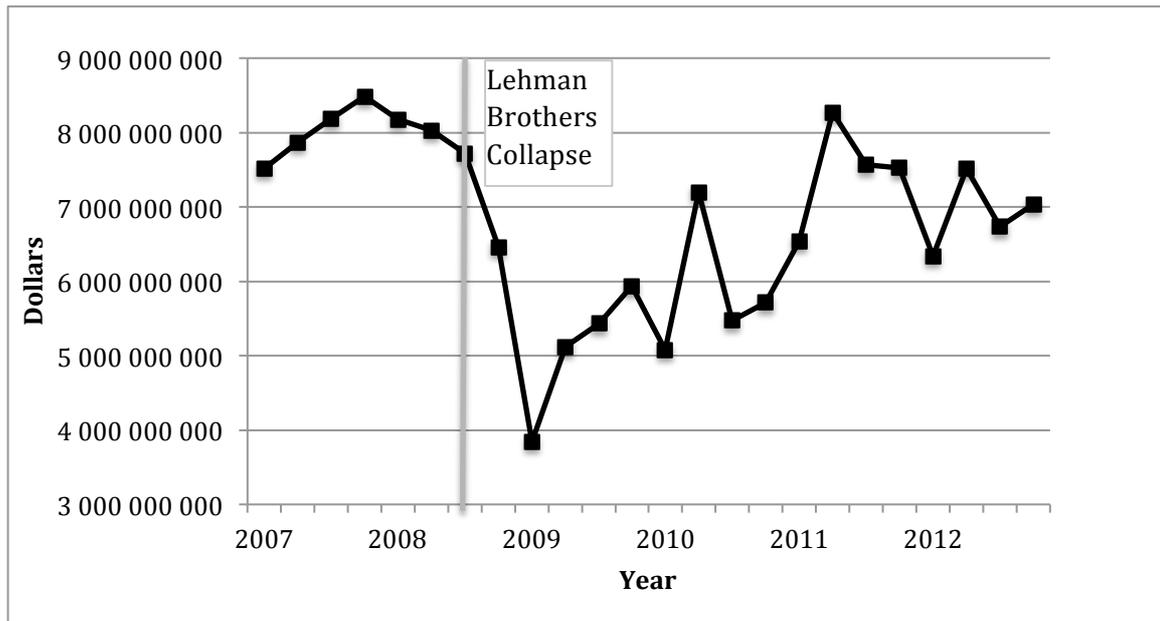
Figure 2. BAA Corporate Bond Rate



Source: FRED, 2015

A decline in asset prices during the crisis caused a drop in the value of collateral, which made it harder for firms to access credit in the market (Mishikin, 2010). Furthermore, the availability of external resources for startup firms decreased. In Figure 3 a sharp decline in the value of venture capital investments is shown after a booming period in the beginning of 2008. Funding for entrepreneurs and startup firms declined as a consequence of the crisis and it caused investors to be increasingly more risk-averse and reluctant to investments, especially in firms with higher risk exposure (Lerner, 2011).

Figure 3. Amount of Venture Capital Investments in The US. 2007-2012



Source: Thomson Reuters, 2015

The crisis caused a rise in uncertainty for the future development of the U.S. economy and no one knew what was going to happen next. Strategies to solve the crisis had not been presented and the collapse of Lehman Brothers hit the market by surprise. This further suppressed investment decisions and consumer demand in the U.S (OECD, 2012).

3. Theoretical Framework

Previous research provides a theoretical framework with mechanisms that can explain how the performance of innovative and non-innovative firms is affected by the financial crisis of 2008. The theories of market power, dynamic capabilities and absorptive captivity and firms access to finance are used in order to explain and state hypotheses, which are tested in the empirical part of this thesis.

The arguments for the existence of a positive relationship between innovation and firm performance begins with Schumpeter's (1934) argument that innovativeness enhances firms' market power by creating a comparative advantage in the market through new products and processes. The innovative firm is able to gain benefits through the establishment of monopoly and can enjoy higher profits in the market. It is also argued that innovative firms can limit competition by their ability to offer highly innovative products and market solutions that are superior to competitors' products. In doing so, they can benefit from brand loyalty from consumers and

reduced price sensitivity of demand, as consumers are willing to pay extra for a highly innovative and unique product (Lieberman and Montgomery, 1988). Innovative products and processes may also create new markets, in which the innovative firm becomes the only actor (Rosenbusch, 2011). These are arguments in favor of innovative firms' advantages in the market, which increase firm performance compared to non-innovative firms. Innovative firms' market power also enables the firm to have a higher profit margin, which is an advantage in times of economic downturns as it makes it possible to decrease prices to attract consumers.

Another theoretical argument that indicates a positive relationship between innovation and firm performance is the theory of absorptive capacity. Absorptive capacity relates to the ability of firms to recognize the value of new information and apply it in their business. Innovative firms are often characterized by being driven by research and development and long processes of innovative activities. These processes involve a high amount of "trial and error"-based experiments and the absorption of external knowledge in order to create successful innovation. The processing of innovations is argued to strengthen the absorptive capacity of firms and lead to more successful and adaptable firms, which make them more robust to changes in the market – for instance, a financial crisis (Rosenbusch, 2011; Van de Ven and Polley, 1992).

Dynamic capability is a theoretical framework related to the argument of absorptive capacity, but it is more focused on dynamics and changing structures, rather than the adoption of external information. Dynamic capability is grounded in the field of evolutionary economics and emphasizes an organization's ability to change, build and reconfigure internal and external competences in changing environments (Teece, 1997). A firm with strong dynamic capabilities is able to develop predictions of consumer preferences, future market problems and technological changes. These firms are characterized by being quick to mobilize resources to address needs and opportunities in the market (Teece, 2014). It is argued that dynamic capabilities are especially strong for firms engaged in innovative activities, and leads to benefits in the market for innovative firms (Teece et al., 1997; Zahra and George, 2002). Being able to adapt to changes is especially important in times of economic crisis, which is a challenging time for firms with decreased economic activity in the market. According to the theory of dynamic capabilities innovative firms should be able to cope with this economic stress better than non-innovative firms and perhaps even find new opportunities in a declining market

(Makkonen, 2014). On basis of the foregoing theoretical argument of the ability of innovative firms to gain market power and their advantage of strong absorptive capabilities and dynamic capabilities hypothesis 1 is stated:

Hypothesis 1. Innovative firms perform *better* than non-innovative firms after the financial crisis.

However, there are theoretical considerations pointing towards the opposite direction and claim that there is a negative relationship between innovative and startup firms' performance. These theories are grounded in firms' access to finance, which is important for firms in order to finance business and perform in the market (Schmookler, 1962; Mach and Wolken 2012). It is not clear if all types of firms have equal access to finance and previous studies have found that it may be harder for innovative firms to get access to finance. An argument for this relates to banks' and investors' tendency to avoid investments in innovation because of the higher risks that may be involved. The business models of innovative firms is argued to be more uncertain than other non-innovative firm, as it often involves completely new products that are new to both investors and consumers (Lee et al, 2015; pederzoli et al 2013; Holton et al, 2014). An example of this can be that investors are less prone to invest in electronic vehicles as it is still uncertain how the market for cars will develop. There is uncertainty about where electronic vehicles will be charged and which laws and regulations that will be imposed on electronic vehicles. Therefore, investors may continue to invest in petrol cars as this industry is seen as more predictable and perhaps a safer investment. Another argument for the fact that innovative firms have less access to finance than non-innovative firms is that there is no guarantee that the innovative firms' research and development activity will pay off and lead to a successful new product. Failure rates are often high for innovative firms and there is uncertainty and risks in investing in innovative startup firms as they might have fewer opportunities to diversify their projects and the returns from innovation may be highly uneven. (Freel, 2007; Sameen, 2014). Information asymmetry between entrepreneur and investor is another argument for innovative firms' financial constraints. This asymmetry is due to the fact that an entrepreneur has better understanding of his/her product than the investor and an innovative product might be harder for the investor to estimate the expected value of (Pederzoli, 2015; Hall and lerner, 2010; Hyytinen et al, 2014). An example is that an entrepreneur has

developed a microchip, which will revolutionize the phone industry. However, the microchip is an extremely technical product, hard to understand for anyone except the entrepreneur and investors avoid investing because they don't know what the product is good for. These reasons cause financial constraints on the innovative firms and decrease their market performance, as it is hard for the innovative firm to raise capital. Another theoretical consideration is based on the demand-pull theory, which emphasizes the role of the business cycle in investments and consumption of innovation. It argues that investments and demand for innovative products increases during business-cycle upswings and decreases during downswings. An example can be that consumers are less likely to buy a completely new or innovative product in harsh economic times and avoid investments in unfamiliar products (Archibugi, 2013). On basis of the foregoing theoretical arguments hypothesis 2 can be stated:

Hypothesis 2. Innovative firms perform *worse* than non-innovative firms after the financial crisis.

4. Data and Method

4.1 Data

The data is collected from the Kauffman Firm Survey, which is a longitudinal panel data survey of start up firms in the U.S. It is one of the largest national samples of start up firms in the U.S. and it is based on information from 4,928 firms that started in 2004 with annual follow up surveys until 2011, which makes a total of 39 434 observations in the dataset. The dataset contains detailed information about firm and owner characteristics and was created using a random sample from the Dun & Bradstreet's database of new businesses (Kauffman, 2015).

4.2 Measuring Innovation

In order to analyze the difference between innovative and non-innovative firm performance a clear definition of the concept innovation is presented. There is no general consensus regarding exactly what innovation is, and how to measure it has been a challenge for economists since the concept was introduced in economics in the beginning of the 20th century. An innovation is a new original product, service or process, which offers a better solution to old problems or satisfies inarticulate needs

(Maranville, 1992). An general definition developed by the OECD states: “*Innovation is the implementation of a new or significantly improved product (good or service) process, a new marketing technique or a new organizational method in business practices, workplace organization or external relations*” (OECD).

Previous research has used different measurements and methods to estimate innovativeness and the choice of measurement is often a question of data availability (Smith, 2005). Innovativeness can be measured by either input or output factors. Input factors are what firms and institutions spend in order to gain innovative products and it is often measured by research and development (R&D) expenditures or time devoted to R&D. The output measurement instead focuses on the registration of innovative products such as patents, copyright and trademarks. Both input and output measurements have limitations, an example is that R&D expenditures do not account for how many innovative products that are actually created by the firm, only how much money is spent on research. On the other hand, product registration such the number of patents does not either truly account for innovation and many registered patents may never be produced or may not be innovative at all (Eurostat, 2005).

In the dataset firms have reported both R&D expenditures and the amount of patents, copyrights and trademarks and a broad measurement of innovation using both input and output factors is applied. The input and output measurements have strong correlation and using either input or output does not have any significant influence on the result. Only firms that been have been engaged in input or output based innovation before the financial crisis are selected as innovative, this is done in order to avoid estimation biases.

4.3 Measuring Firm Performance

Firm performance is a complex concept to measure and it is dependent on data availability and the focus of the study. The reason is that firm performance is not a one-dimensional concept and can relate to a number of categories, for example, financial, customer or environmental performance (Richard et al, 2009). This study focuses on the financial performance of firms in the U.S. This is because I find it most interesting to evaluate the financial performance and profitability of firms during the economic crisis, and the crisis direct impact was mainly to financial performance of firms in the U.S. Firm performance is measured through firms’ return on asset (ROA), which explicitly measures whether the firm is able to generate return on assets rather than simply showing robust return on sales. Return on equity (ROE) would be another possible measurement of firm’s financial performance, which is a measurement

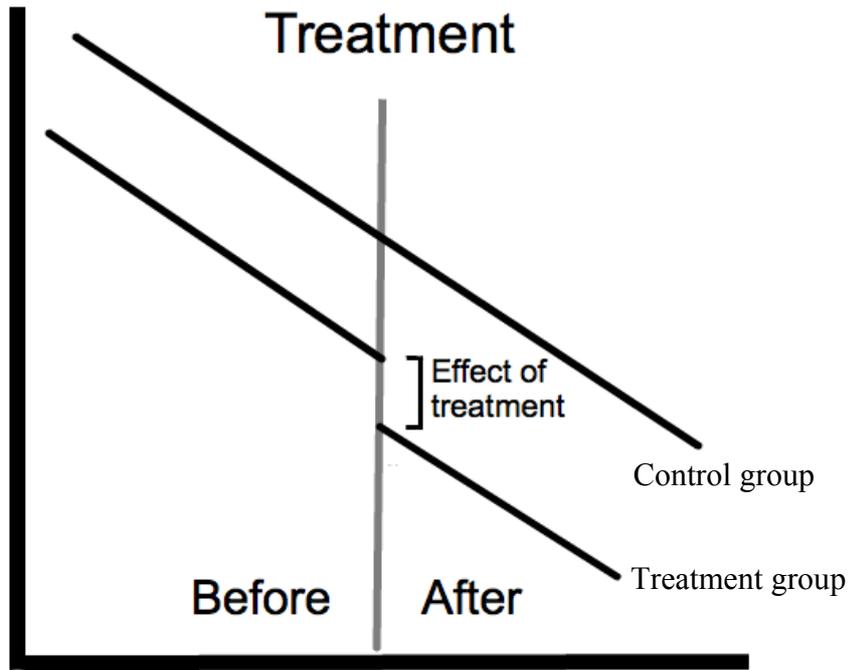
focusing on return to the shareholders of the firm. However, all firms in the dataset were established in 2004 and many of them did not have any shareholders during the time period. ROE as a measurement of firm performance has also been criticized for making it possible for firms to maintain artificially high ROE by debt leverage and stock buybacks financed through borrowing (Hagel et al, 2010). Therefore, ROA is the performance indicator in this study, as it can't be distorted by financial strategies and gives a clear measurement if firms are able to generate adequate return on its assets, which also make firms of different sizes comparable.

4.4 Method

Previous literature suggests several possible approaches to study how innovativeness affects firm performance during the financial crisis. Based on the performance variable in this thesis being return to asset, a simple approach is to compare the mean value of firms' performance after the financial crisis and calculate the difference in performance based on if the firm is innovative or non-innovative. This would be an easy method to apply, but the estimation would most likely be biased. This is because a simple-difference model would only compare the groups after the financial crisis and not before, and it would not be possible to know if the difference between the groups was caused by the ability to be innovative during financial crisis or some other factor. The same problem occurs even if the groups are compared both before and after the crisis. For example, if the result indicates that firm performance decreases after the financial crisis compared to before the crisis, it does not have to be because of the financial crisis, and can instead be because of a national boycott of the firms (Gertler et al, 2011). These are examples of causal inference problems and it is important to establish that a relationship is causal; otherwise it is not possible to know what causes the effect.

This thesis applies a differences-in-differences (DiD) research design in order to test if innovative firms perform better or worse than non-innovative firms after the financial crisis in 2008 in order to overcome the causality problems. The DiD method is often used in evaluating implementations of political reforms, or in a medical setting when control groups are given placebo treatment and the treatment groups are given medicine in order to see the effect of the treatment (Lecher, 2011). This is done to observe the difference between the groups before and after the treatment. The general idea of the DiD method is illustrated in Figure 4.

Figure 4. Difference-in-Difference Method



Source: Author

As shown in Figure 4 the groups are at a common trend before the treatment, but after the treatment (vertical line) the treatment groups decrease more from the trend than the control group. This is how the effect of the treatment is estimated. In this study the treatment is innovativeness, and the financial crisis is used as a natural experiment to see how two groups of firms that are assumed to be completely similar, apart from their ability to innovate, react to the financial crisis. The DiD method difference out common time effects and controls for fixed characteristics in order to identify the effect of innovativeness on firm performance during the financial crisis (Burgess, 2013). A general specification of the difference-in-difference model used:

$$Y_{it} = a_i + \lambda_t + \rho D_{it} + X_{it}\beta + \varepsilon_{it} \quad (1)$$

Individuals and time is indexed by i and t , a_i are characteristics of individuals that do not change over time and λ_t are time fixed effects. X_{it} are control variables and ε_{it} is the error term. The estimation of interest is ρ , which is the difference-in-difference estimation. The difference-in-differences method enables us to account for differences between the treatment and comparison group that are constant over time, but it will not be able to eliminate the difference between the groups that change over time. This is the defining assumption of the DiD method and it is called the common trend

assumption, which implies that if the treated group had not been subjected to the treatment, both groups would have continued on the same trend. In Figure 2, this would mean that the treatment group is assumed to have continued on the exact same downward trend as it had before the treatment.

The validity of the common trend assumption is untestable, as it is not observable how the groups would have reacted if the treatment never occurred. It is especially hard in this thesis, as it is based on an occurring event (financial crisis) and it is not in a controlled experimental setting. However, the common trend assumption can be supported by comparing the groups before the treatment and observe the trend of the outcome variable. If the outcome trend follows the same trend this serves as an indicator that this trend would have continued on the same path if the treatment never occurred. In this thesis the same firms are observed for 5 years before the crisis, which supports the common trend assumption. Another strategy applied to provide supporting evidence of the common trend assumption is to compare similarities between other control variables between innovative and non-innovative firms to see similarities before the crisis. The difference-in-difference model used in this thesis is specified as:

$$ROA = \beta_0 + \beta_1 D^{Post} + \beta_2 D^{Tr} + \beta_3 D^{Post} D^{Tr} + \beta_4 X + \varepsilon \quad (2)$$

ROA is the dependent outcome variable and it stands for return on asset, which is used as an indicator of firm performance. D^{Post} is a dummy variable for the second time period. D^{Tr} is a dummy for the treatment group. The main coefficient is the β_3 coefficient, which is capturing the interaction between the treatment and post dummy and it is the difference-in-difference estimation. X is a vector of control variates and ε is the error term.

4.5 Matching and Coarsened Exact Matching

When applying the DiD method it is desirable to replicate a randomized sample as closely as possible by obtaining groups with similar covariate distribution. The reason is that for estimating the causal effects the treated and control groups should be randomly selected and also randomly different from one another on all background covariates (Stuart, 2010). In previous studies, which apply the difference-in-difference method on observational data there is a lack of adjustments to correct for the data not being randomly selected and sometimes the problem is not even discussed (Rosenbaum and Lu, 2004). When the subjects are not assigned to the

treatment or control group at random there may be hidden biases. An example of this could be a study, which assesses the impact of school meal support program on students' exam scores. The program is free for anyone to enter and the enrollment in the program is not randomized. Poorer students may be more prone to sign up for the program, as it offers a daily free meal while richer students prefer to bring their own meal. This self-selection to the treatment group by poorer students will make the baseline characteristics of the treated group (support group) and control group (other students) differ systematically from each other. This affects the comparison between the groups, as the difference is no longer only if they are in the support program but also if they are rich or poor. Therefore, one must account for these differences in baseline characteristics when estimating the casual effects (Getler et al, 2010).

This study is based on observational data and it is not a randomized experiment. In order to account for the systematic differences between innovative and non-innovative firms a matching method is used to replicate randomized samples as closely as possible and balance the two groups. Matching is a method, which statistically selects and compares individuals in the treatment and control group with similar covariate distribution. The method consists in pruning the sample to enhance the balance between the treatment and control group before the treatment, which makes the empirical distribution covariates of the two groups more similar. By doing this, the estimation becomes less imbalanced and model dependent while being more precise (Stuart, 2010).

This thesis is using coarsened exact matching (CEM) technique to estimate unobserved potential outcomes by comparing treated and control groups that are as similar as possible to each other. CEM is an easy method to work with, as it does not need continues balance checks and the adjustment of one variable does not affect balance of any other variable (King et al, 2010). The basic idea of CEM is to coarsen and recode each variable so similar values are assigned the same numerical value. This is done by an exact matching algorithm, which determine matches and pair similar units with each other and unmatched units are dropped from the sample. In the end the coarsened data is retransformed to its original values (Iacus and King, 2011). To coarsen the data may at first seem wrong, as some information is lost in the process. However, it should be noted that even before an analyst obtains data the quantities being measured are typically coarsened to some degree and it is never possible to get all information. An example can be data used by political scientist on public opinion where the person's answer is reduced to a scale of "agree, neutral,

disagree". The person opinion is possibility far more complicated and can't be measured in this way, but the data is being coarsened while being collected for simplicity. Coarsening is also applied in other social sciences to make estimations easier and another example is that religious beliefs are often grouped to four broad categories, when there are in fact millions of beliefs. Iacus and King (2011) argue that coarsening in CEM is safer than at the data collecting stage as it can be controlled and the methods are similar in nature as both create small difference, small enough to trust in statistical modeling. Another advantage with CEM is that the coarsening can be chosen by the analyst, rather than by an automated algorithm. This enables the user to choose and select logical category boundaries, which is a feature not possible in other common matching methods (Blackwell et al, 2010). By being able to manually categorize the groups it is possible to arrange groups that we know are similar, for example if individuals from the same schooling year can be grouped together, or countries with similar income levels. This is done so the coarsening for each variable generates substantively indistinguishable values, which are grouped and assigned the same numerical value to increase the balance of the data and the number of matched units (Iacus and King, 2011).

In this study the coarsening is based on number of employees in the firms. Natural breaks in sample are found on 1, 5, 10, 14, 25, 35, 50 employees and these are used as boundaries for the matching. After the matching an overall imbalance measurement (L-statistic) based on the difference between the multidimensional histogram of all pretreatment covariates is checked to see if the data is more balanced after the CEM matching. The L statistic measures imbalance between 0 to 1 and $L1=0$ indicates perfect global balance in the data (Blackwell et al, 2010).

4.6 Limitations

A limitation to the method is that the difference-in-difference estimation rests on the assumption of common trends, which assumes that without the financial crisis innovative and non-innovative firms would have continued on the same trend as before the crisis, but the assumption is supported in this thesis by the pre crisis trend. Another limitation to the difference in difference method is that the method estimates any difference in trends between the treatment and comparison groups after the event. If there is any other factor that affects the difference in the trends between the two groups, then the estimation will be biased. This would be the case if only the treatment group or control group is affected by some other factor at the same time as the financial crisis. (Gertler et al, 2011).

CEM matching is an effective way to enhance the difference-in-difference estimation, but it does also have its limitations. Firstly, matching of the treatment and control group can only be based on observed background characteristics and it is not possible to rule out biases from unobserved characteristics. Therefore, since I can't prove that any unobserved background characteristics exist, it is assumed that none exists. Another limitation concerns the concept of innovativeness, which does not have any clear definition. However, the broad approximation of innovation, which includes R&D expenditure, patents, copyright and trademark, is highly correlated with one another and similar measurements have been used in previous studies (Jalles, 2010; Davila et al, 2012).

5. Result and Analysis

5.1 Common Time Trend Assumption

The common time trend assumption is as discussed untestable but the development of the control and dependent variables before the crisis support that the assumption. Table 1 shows the mean value, standard deviation and correlation of the control variables¹ for innovative and non-innovative firms between 2004 and 2008. The correlation between the variables for innovative and non-innovative firms is compared to see to what extent the variables fluctuate together. The mean values of the control variables are strongly correlated for both the innovative and non-innovative group before the financial crisis in 2008. The strongest correlation can be seen in the development of the number of employees, which has a remarkably high correlation of 0,995. Innovative firms have a higher mean value of employees, but the two groups are at a similar time trends. The owners' experience in the business and educational level also has a high correlation and the mean value for the variables is almost equalized, indicating that the owners of innovative and non-innovative companies have a similar professional and educational background. The control variables have a strong correlation before the financial crisis, which is an indication that non-innovative and innovative firms are very similar in many aspects regarding the firm structure and financial situation. The mean value between innovative and non-innovative groups is not a pair, but this is of no concern and is for controlled for using the difference in difference method.

¹ More details on the control variables are found in Appendix 2.

² More on CEM and the algorithm is explained in detail by King (2010)

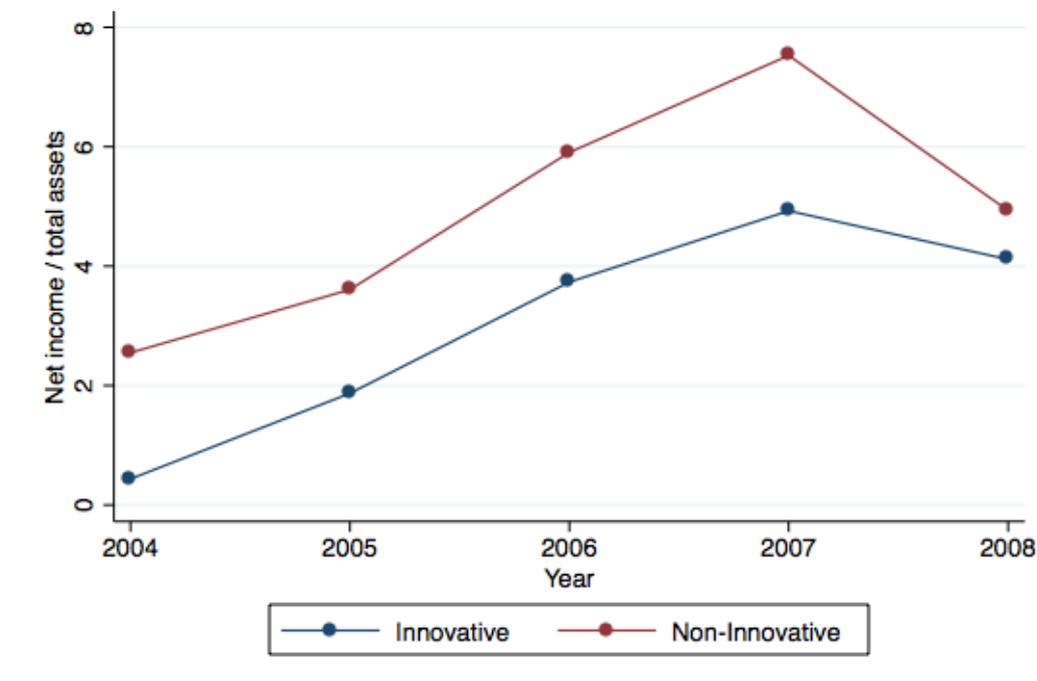
Table 1. Descriptive Statistics of Control Variables

Variable	Correlation	Innovative	Non-Innovative
Employees (Number of)	0.995	3.517583 (6.81671)	2.123766 (7.896779)
Owner experience (Years)	0.93	12.52574 (9.752877)	13.051271 (10.24143)
Owners education (Highest level of education)	0.79	6.746504 (2.03)	6.045956 (2.11)
Firm Expenditures (Dollars)	0.96	252898.9 (319378)	240404 (617304)

Note: Mean value and standard deviation in parentheses.

The dependent variable of interest in this this essay is performance, which is measured as ROA. Figure 5 presents the unmatched samples mean-value of ROA between 2004-2008. The figure reveals that non-innovative firms performed better on average than innovative firms between the years 2004-2008. However, the two groups do have similar trends before the financial crisis and a correlation of 0,938 even before matching.

Figure 5. Average Firm Performance (Unmatched sample)



This can be an indicator that the parallel trend assumption is valid, an important assumption in order for the difference-in-difference estimation to be of relevance. The variation in the ROA asset indicator is mainly driven by variation in the net income of

the firms and total assets remains rather stable at a decreasing trend during the time period for both of the groups (See appendix 1).

5.2 Coarsened Exact Matching

By applying the CEM matching technique the correlation of the trends increases, and it also improves the estimation of causal inference. The goal of the matching process is to balance the data set by matching innovative and non-innovative firms prior to the financial crisis so that they are as similar as possible, apart from being either innovative or non-innovative. The data is matched on pre-treatment observations of number of firm employees, educational level and the owners experience in the business.

Table 2 shows a comparison between the matched and unmatched sample. Of a total of 39,424 variable observations 35,226 matched and 4197 were unmatched. The mean value and standard deviation of the sample is reduced by the CEM method and this is due to coarsening of the data by the CEM matching algorithm². The overall imbalance measurement (L-statistic) is used to check if the data is more balanced after the CEM matching. Before coarsening, the balance of the data set was 0.356 and after coarsening it showed 0.193, which is a clear improvement of the global balance of the two groups.

Table 2. Matched Variables Before and After Coarsened Exact Matching

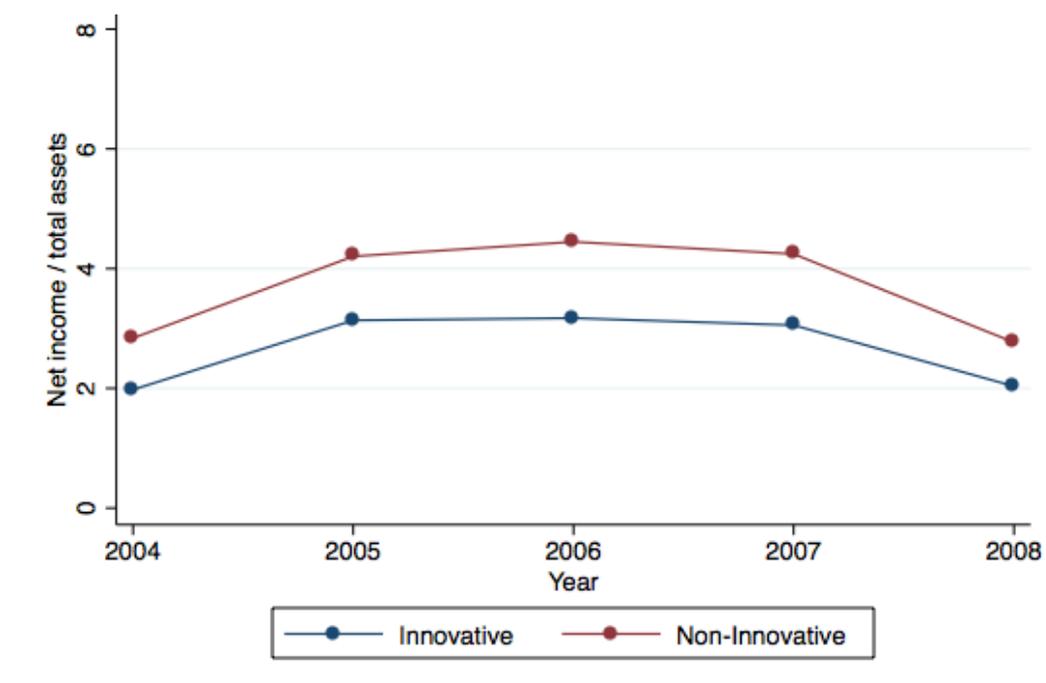
Variable	Pre-CEM		Post-CEM	
	Innovative	Non-innovative	Innovative	Non-innovative
Owner experience	12.82	13.05	12.39	14.4
	(9.75)	(10.20)	(9.49)	(9.05)
Obs	12704	10538	11868	10169
Owner education	6.75	6.05	6.71	6.02
	(2.03)	(2.11)	(2.01)	(2.10)
Obs	13237	12405	12967	12088
Employees	3.51	2.12	2.9	2.6
	(6.80)	(7.89)	(4.58)	(4.89)
Obs	13237	10902	12405	10553
Firm Expenditures	252898.9	240404	224318.6	187707
	319378	617304	295952	280945
Obs	13124	10843	12276	10467

Note: Mean value and standard deviation in parentheses.

² More on CEM and the algorithm is explained in detail by King (2010)

In Figure 6 the average firm performance before the financial crisis with the CEM matched dataset is shown. When the balance between the innovative and non-innovative firms is improved by the matching technique the correlation of firm performance before the financial crisis becomes stronger. This result further supports the argument that innovative and non-innovative firms were similar pre-crisis and that the common trend assumption holds. This enables this analysis to move forward and in the next section the difference-in-difference estimate of firm performance during the financial crisis is presented.

Figure 6. Average Firm Performance (Unmatched sample)



The DiD estimation for both the original and matched sample is shown in Table 3. In Table 3 non-innovative firms performed better before the financial crisis in 2008 compared to the innovative firms. However, in the second period after the financial crisis the roles switched and instead innovative firms performed better. The difference-in-difference estimation shows that the impact of innovativeness to firm performance is 4.25 in the original and 1.534 in the matched sample when the trend from the non-innovative firms is subtracted. This is an interesting result as it indicates that the difference-in-difference estimation between innovative and non-innovative firms is higher in the original sample compared to the matched sample. The reason is that in the matched sample firms' that are similar to each other are compared and the groups are balanced, while in the original sample any firm is compared with each other and this gives a more volatile result. However, both the original and match

sample indicate the same thing, innovative firms have performed better than non-innovative firms after the financial crisis.

Table 3. Difference-in-Difference Estimation of Firm Performance

Sample	Before Financial Crisis		After Financial Crisis		Diff-in-Diff
	Innovative	Non-inoovative	Innovative	Non-innovative	
Original	3.543** (0.681)	5.245** (0.726)	7.467** (1.128)	4.913** (1.285)	4.25** (1.659)
Matched	2.675*** (0.6123)	3.700*** (0.720)	3.343*** (1.012)	2.844*** (0.823)	1.534** (1.453)

Note: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The control variables are included in the estimation but not shown in the table.

The results become clearer in Figure 7 and 8 where the average firm performance for innovative and non-innovative firms is plotted between 2004-2011 for both the unmatched and matched sample. It also makes it possible to draw conclusion of how firm performance change every year.

Figure 7. Average Firm Performance 2004-2011 (Unmatched sample)

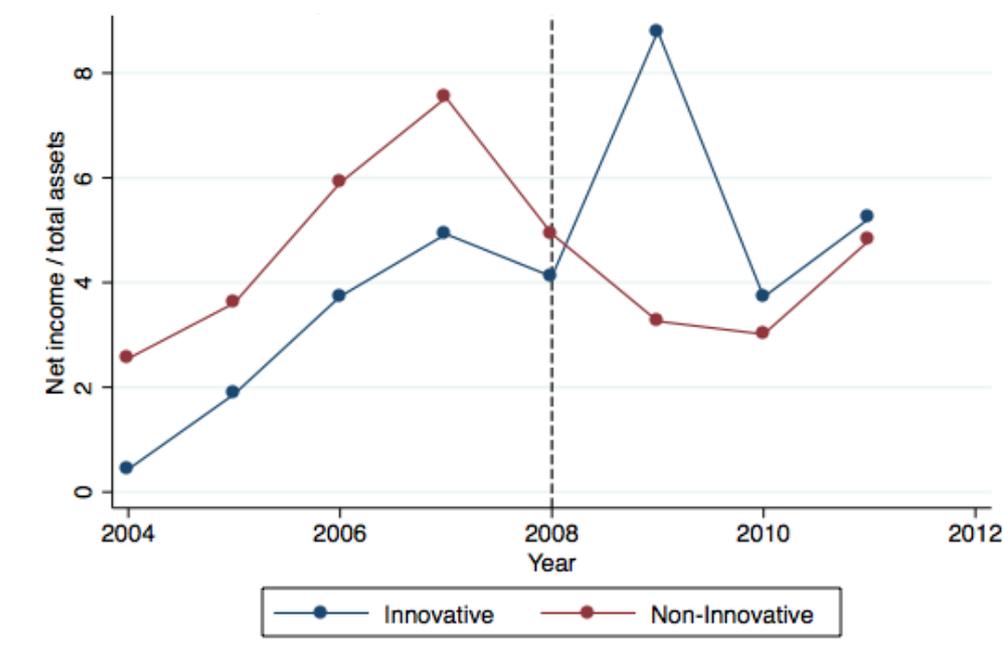
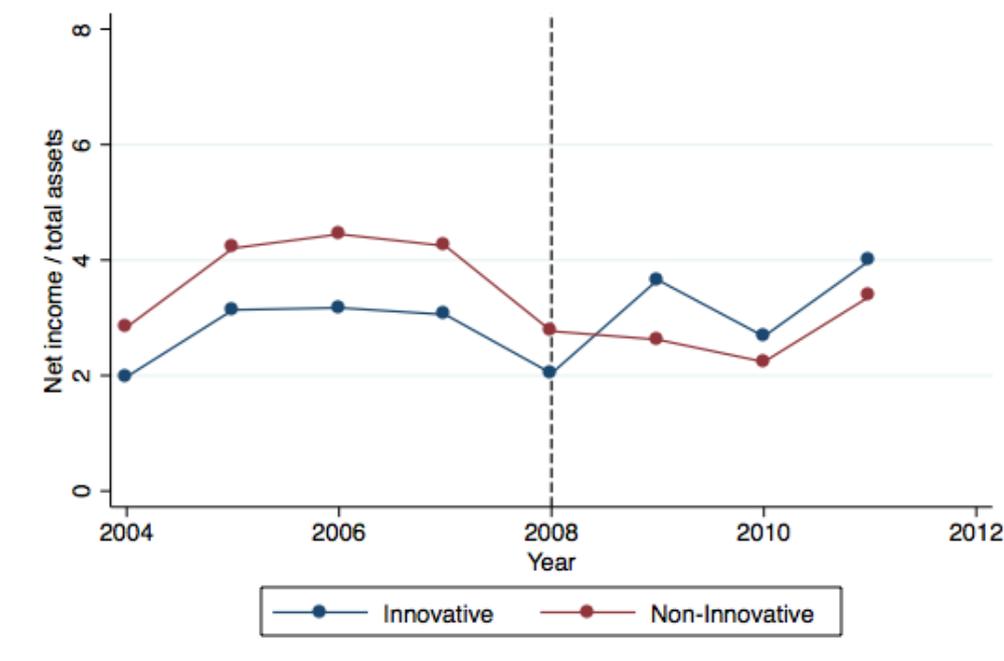


Figure 8. Average Firm Performance 2004-2011 (Coarsened Exact Matched)



The result from the matched and unmatched sample in Figure 7 and 8 shows that the correlation between the samples before the financial crisis is very high and that the variables follow a parallel trend. The impact of the financial crisis on firm performance is much stronger in the unmatched sample but in the more balanced CEM sample the shock from the financial crisis is less strong.

This result indicates that *hypothesis 1* cannot be rejected and that innovative firms may perform better than non-innovative firms during the financial crisis in 2008. *Hypothesis 2* of innovative firms performance becomes worse compared to non-innovative firms is rejected.

6. Discussion

The result from the difference-in-difference estimation of firm performance indicates that innovative firms performed better than non-innovative firms after the financial crisis. From being at parallel trends for 5 continuous years, with non-innovative firms showing better performance before the crisis the roles changed and innovative firms started to dominate in terms of performance. This result is supported by the theoretical arguments of innovative firms' advantages in market power, dynamic capabilities and absorptive capacity in times of economic crisis.

According to the argument of market power, Schumpeter (1934) argued that innovativeness enhances firms' market power and allows innovative firms to gain advantages in the market by being able to establish monopolies and maintain prices

above market prices, which has a positive effect on firm performance. This may be the reason as to why the innovative firms performed better after the financial crisis. As the market demand went down in 2008, innovative firms had the possibility to lower prices without losing profitability compared to non-innovative firms, which are assumed to have a smaller profit margin and less market power. Another reason that may explain the result is through the theory of absorptive capacity. According to this theory innovative firms are better at recognizing the value of new information and applying it in their business model. This can be the reason why innovative firms are more robust to the financial crisis than non-innovative firms. It is possible that innovative firms are better at predicting changes in the market and adapt their business to new circumstances. An example could be an innovative mobile application developer that can quickly collect and use information about changes in in the market. As a result of the financial crisis the developer decides to refocus the business to meet new demands and starts to sell mobile applications for unemployed people seeking new jobs. This process may not be as easy for an non-innovative firm that perhaps sees changes in the market, but has a harder time adapting the business quickly as the non-innovative business may be more capital intensive. The theory of dynamic capabilities relates to a similar effect but is more focused on the ability of firms to change, build and reconfigure both internally and externally to changes in the business environment. The start of the financial crisis of 2008 generated a wave of economic unrest in all of the U.S. and innovative firms' ability to quickly mobilize resources and address needs in the market as a result of the financial crisis may be the reason why innovative firms perform better after the financial crisis than before.

Hypothesis 2 is rejected and the result indicates that innovative firms do not perform worse than non-innovative firms. This could be because access to finance is an overrated factor in determining firm performance or has a delayed impact. According to the theoretical arguments, non-innovative firms should have an advantage in firm performance compared to innovative firms as they can more easily access finance in times of economic crisis. However, this is not mirrored in the result and this may be because access to finance has a delayed effect, which is seen in Figure 7-8. The mean value of ROA is plotted for both the original and matched sample and directly after the crisis the innovative firms ROA substantially increases but starts to fall in 2010, two years after the crisis breaking point. The same drop is not seen among the non-innovative firms and this may be because of a delayed reaction on the financial constraint put on the innovative firms.

The differences in outcome between the original sample and the CEM matched sample gives two different estimations of the effect innovation has on firm performance in times of the financial crisis. The unbalanced original sample gives a much higher estimation of the impact of innovation on firm performance compared to the balanced CEM estimation. This result indicates the need for applying matching method in order to correctly estimate the causal effect and without it the effect of innovation on firm performance would have been overestimated.

The result is interesting as it can indicate that innovative firms absorbed some of the market from the non-innovative firms after the financial crisis. The performance of non-innovative firms decreased, while it increased for the innovative firms. An indication that the financial crisis was a breaking point for firms in the US and from the crisis onwards it may be innovative firms that are dominating the economy. However, as seen in figure 2 and 3 the performance of innovative firms is at its peak in 2009, the year after the crisis and falls back in 2010, to still be above non-innovative firms but not with as much as in 2009. This can be an indication that the innovative firms had an advantage directly after the crisis compared to non-innovative firms, an advantage which did not persist after 2010. This may be because of political and economic intervention by the U.S. government and Federal Reserve as a reaction to the financial crisis, which had a delayed impact on the economy and may have benefited non-innovative firms more.

7. Conclusions

Governments all over the world have put a lot of attention on innovation as a means of sustaining economic growth and to increase firm performance. In 2008 the financial crisis hit the world economy and previous research yields ambiguous results as to whether innovative firms perform better or worse than non-innovative firms during economic downturns.

This study examines the impact of innovation on firm performance in the U.S. during the financial crisis of 2008. A difference-in-difference model is applied to estimate the casual relationship combined with CEM, which is a matching method to enhance the causal inference and to balance the treatment and control group. The result indicates that innovative firms performed better than non-innovative firms during the financial crisis, but that the positive effect of being innovative is less in the CEM sample. This result is interesting as it supports the strategy of many

governments to support innovation and the result indicates that being innovative may work as way out of economic crises. The reason innovative firms perform better and resist the economic downturn may be because of their way to adapt and find new market solutions, extract new information from the market and apply it to their business model. Being innovative is not only about creating innovative products, it seems to be a way of firm-organization and a mindset of the entrepreneurs, which enables firms to remain and increase performance, even in times of financial crisis.

For future research it would be interesting to see how innovation impacts other firm performance indicators. An example could be to study if innovativeness increases environmental performance of firms and if innovative firms are more adaptable to a world where consumers demand environmentally friendly products. I also hope that future difference-in-differences studies will apply CEM and other matching technique, to avoid biases and enhance causal interpretation.

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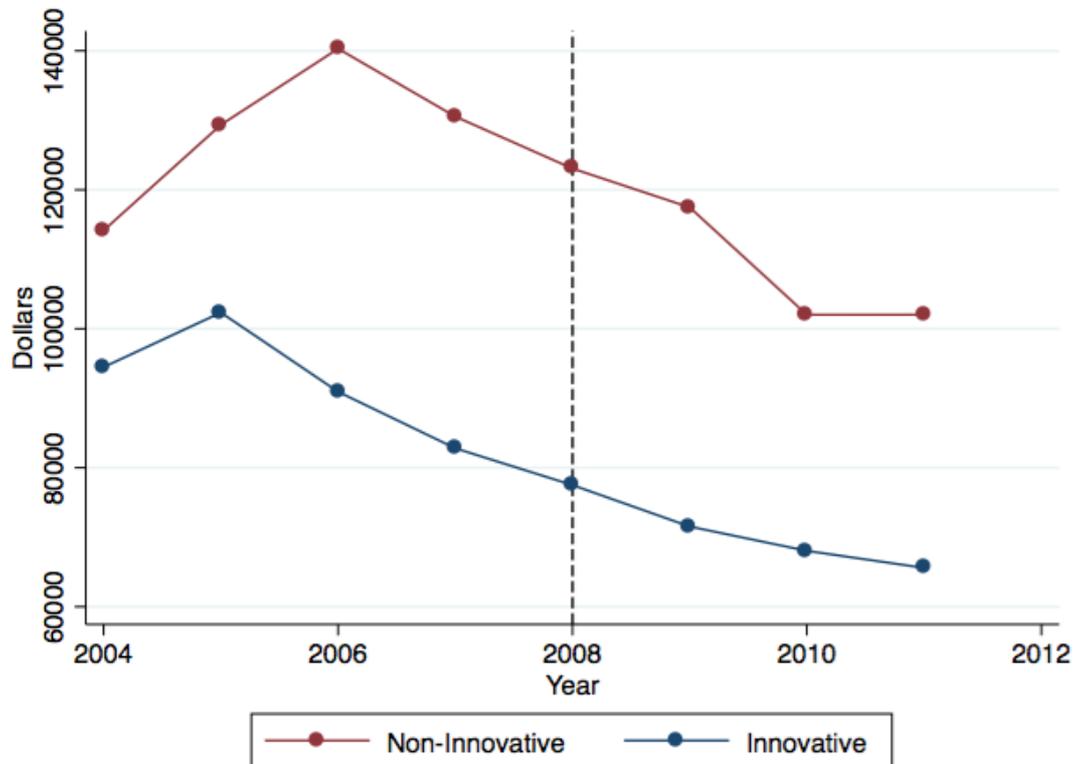
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Appendix 1.

Figure 6. Firms Total Assets



Appendix 2

Highest Level of Education Completed by Owner

Value	Category	Frequency.
1	Less than 9th grade	64
2	Some high school, no diploma	352
3	High school graduate	2217
4	Technical, trade or vocational degree	1464
5	Some college, no degree	4955
6	Associate degree	1923
7	Bachelor degree	5918
8	Some graduate school, no degree	1607
9	Master's degree	3632
10	Professional school or doctorate	1645
Total obs		23777