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Industry and Firm effects and their Impact on Firm Performance: Changes during the Economic Crisis

Name Student: Cosmas van Heck
Student ID number: 456568

Supervisor: dr. R. de Bliek
Second assessor: dr. S. Pfeil

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Abstract

This study aims to contribute to the long-standing debate on the impact of firm effects and industry effects on firm performance. The aspect that distinguishes this research from earlier studies on the topic is the distinction between a regular economic period and a period of economic crisis. No studies have been conducted yet on the differences between firm and industry effects in these two types of periods. To research this a sample of 1032 firms based in the United Kingdom is used, containing data on firm performance between the years 2004 and 2009. Two different statistical methods are used to determine possible changes. First a panel data regression, the Arellano-Bond method, is ran using the full data sample. After this the seemingly unrelated estimations method is used to determine the relationships for the years 2006 and 2009 separately. Here the 2006 regression represents the pre-crisis period and the 2009 regression represents the crisis period.

The results show no difference in the industry effect between the pre-crisis period (2004-2006) and the crisis period (2007-2009). Concerning the firm effect a statistically significant change was discovered, showing that the firm effect decreased in the crisis period compared to the pre-crisis period.

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1. Introduction

In the history of mankind periods of financial prosperity and periods of financial downturn have always alternated. The latest big financial crisis the western world had to deal with was the crisis between 2007 and 2009. The housing market in the United Kingdom suffered hard and the average property decreased by about 20% in a period of 16 months (Morrison, 2018). This pushed a lot of house owners into financial troubles as their mortgage became higher than the resell value of their house. Due to the shortage of money at the consumers the whole economy got into recession, which caused unemployment to increase by over 50%. To the majority of the western population the financial crisis came as a shock, as for years there was a common belief that the economic cycles had been figured out and that there would not be a big crisis like the great depression in the 1930's or the oil crisis in the 1980's again. The 2007-2009 crisis, hereafter called the economic crisis, should have served as a wake up call for modern economists and demonstrate that we can never let down our guard. Even though new ways of preventing such a situation to occur again have been discovered, many politicians believe that we are heading for a new crisis once more (Alam, 2018).

For firms it is therefore crucial to understand what drives economic success so they know how to protect themselves against a potentially imminent financial crisis. Ever since the 1950's there has been an on-going debate in the strategy economics literature on the main drivers of this so called firm performance. Some researchers state that the most important drivers of firm performance are the characteristics of the sector in which a firm operates. Bain for example found that if the level of concentration within a sector that is protected by entry barriers is greater, the average rate of return of the firms active in this sector is higher (Bain, 1951). In the opposing camp are researchers who retain internal factors more important in determining the profitability of a firm. Examples of these internal factors are the built up cash reserves and human capital among the employees (Hall & Wahab, 2007).

The main idea in economic textbooks is that the unique strategy of a firm can influence its level of firm performance regardless of the characteristics of the markets in which they operate. If the structure of the markets were the only factor to influence firm performance, there would be no point in obtaining any form of economics or management degree and business schools would presumably be closed. This reasoning is of course a straw man. The supporters of the idea that market conditions influence firm performance would never claim that these conditions are the only factors of importance. Rather, the study of firm performance is about the importance of internal factors relative to the importance of external factors.

Though many studies on the relative importance of these so called firm effects and industry effects have been carried out, no study looked at the change of these effects in a tough economic period: the economic crisis of 2007-2009. Are the results found consistent in both prosperous economic times and times of turmoil? It makes sense to expect that if money is scarce, it is mostly used to buy necessary products and not so much for luxury products. Following this reasoning, industries that offer products that are basic needs should suffer less from a financial crisis and therefore the industry effect should be stronger in these times. Benmelech et al. (2017) for example found that the car industry suffered a relatively large decline in sales during the financial crisis in the beginning of this century compared to other industries. Therefore this paper will investigate the magnitude of industry and firm effects during the financial crisis of 2007-2009.
The main question is:

“What happened to the magnitude of firm and industry effects for UK firms during the 2007-2009 financial crisis?”

To aid in answering this question an analysis of existing literature will be done aiming to answer three sub questions:

- What is firm performance?
- What are firm and industry effects and how can they explain firm performance?
- What is an economic crisis and how can it impact firm performance?

Using the answers to these three sub questions, two hypotheses are formulated regarding the answer to the main question. These hypotheses are then tested with statistical research. This research makes use of data from the Compustat – Global database. The research sample contains profitability data of firms in the United Kingdom for the years 2004 until 2009. Among the important variables are return on assets, which will be used as a firm performance measure, and the standard industrial classification code of a firm. This code is used to categorise the firms in different industries, which enables the determination of the industry effect. To find the relation between firm effects, industry effects and firm performance two types of regressions are used. Firstly, a panel data regression for all firms in the sample for the full time period. After this, two separate cross-sectional regressions are conducted for the years 2006 and 2009. The year 2006 represents the period before the crisis and the year 2009 represents the period of the crisis.

The remainder of the paper discusses the results of previous studies on firm performance in the theoretical framework section. After this the Methodology section names and explains the methods that are used to analyse the firm and industry effects and the Data section describes the process of receiving and modifying the data. The following Results section presents the outcomes of the analysis and the implications they have. Finally, the results are be summarised in the conclusion section in addition to some recommendations for future research based on the limitations of the current study.

2. Theoretical framework

2.1 What is firm performance?

Successful and independent companies are an important ingredient of the modern western society. Economists have compared the way they drive a nation's economic, political, social and cultural development to the way an engine drives a car forward. Firm performance is therefore not only a relevant topic for firm managers, but also for researchers and politicians. One would think that such a key concept would therefore have a universal definition or measurement but quite the opposite is true: in the management literature there is no consensus about either of these things (Taouab & Issor, 2019).

During the 1950s firm performance was seen as a measure of organisational efficiency. This represents the extent to which an organisation of limited capital and means achieves its goals without taking excessive toll on its members. The performance criteria used were productivity, flexibility and inter organisational tensions (Georgopoulos & Tannenbaum, 1957). In the decennia that followed, new ways of evaluating firm performance were explored and therefore the definition was changed accordingly. During the 1960s and 1970s firm performance was seen as an organisation's ability of exploiting its environment and using the limited resources available to them (Yuchtman & Seashore, 1967).

Porter (1986) had a slightly different view and stated that firm performance could be seen as the ability of a firm to create value for its shareholders. This definition was a more tangible one than the ones before, and Harrison and Freeman (1999) agreed with this stating that an efficient organisation with a high level of performance is an organisation that satisfies the demands of its stakeholders.

Now most of these concepts of firm performance make sense to a reader but they leave the question how firm performance should be measured unanswered. Lebans and Euske (2002) specifically stated that to be able to report a firm's performance level, the results have to be able to be quantified. The most common measurement of firm performance therefore is return on assets (ROA) or profitability (Burton et al., 2002). Researchers have long been trying to explain the differences in ROA across firms. Their explanations for this can mostly be divided up into two categories: a category that focuses on industry effects and a category that focuses on firm effects.

2.2 What are firm and industry effects, and how do they explain firm performance?

The first category focuses on the industry effect, which refers to effects influenced by the characteristics of the industry in which the firm operates. This effect can be used to explain performance differences across industries but not within industries. In the 1930s Ed Mason claimed that there was a causal relationship between the structure of a market and the profitability of the firms in it. His reasoning was that the way a market was structured, for example operationalised using market concentration, formed constraints that limited the different strategies that firms could implement. This limited set of strategies then led to congruent performance of the firms in the same industry (Mason, 1939). Porter (1985) showed the importance of the relationship between industry characteristics and firm performance in his Five Forces Model. The five forces he spoke about were bargaining power of suppliers, threat of substitutes, bargaining power of buyers, threat of new entrants and industry rivalry. According to his studies these were the five most important determinants of the profitability of an industry.

The second category focuses on the firm effect and can be used to explain the differences in firm performance within industries. Firm effects refer to all kinds of internal differences across firms that may have an impact on the level of performance. Examples of these are differences in the human capital available or the brand equity (Ngobo, 2011)

Since these two theories can be translated into testable hypotheses, a multitude of researchers has done empirical studies to resolve this discussion. In these studies firm effects are operationalised by some form of past performance by the firm, for example the average return on assets of a firm for 3 years before the research period. Industry effects are operationalised similarly: some form of past performance by firms in an industry. One of the very first studies on the subject was performed by Schmalensee. He divided the variance of returns into corporate effects, market share effects and industry

effects. The implications of this study were that the firm effects did not exist, that the influence of the market share was negligible and that the industry effects explained 19% of the observed variance in firm performance (Schmalensee, 1985).
Whereas Schmalensee's study was focused on one year, six years later Rumelt (1991) used the same sample but extended his analysis to a timespan of four years in order to capture a full business cycle. The outcome stood in heavy contrast with the previously found results. Rumelt found that the firm effects were accountable for around 46% of the variation in performance and that a mere 8% of the differences was caused by stable industry effects. This study seemed to imply that firms are inherently different to each other and that these differences drive a wedge in the levels of firm performance.

In an attempt to explain the crucial differences between the research of Schmalensee and Rumelt, Roquebert et al. replicated their studies on a larger and more diversified sample and over a longer time period. Their findings were that industry effects were accountable for 10% of the firm performance and the firm effect for over 37% (Roquebert et al., 1996). McGahan and Porter (1997) again expanded the sample size and the duration of the time series. In addition to this they included all sectors of the economy except for the financial sector, whereas the previously discussed studies only included the manufacturing sector. They found that the industry effects accounted for 17% and firm effects for 30% of the explained variance in firm performance. A more recent study by the same authors focused on the same subject but this time used a different statistical method and a different sample. They found the industry effect to account for 9% and the firm effect to explain 32.5% of the firm performance (McGahan & Porter, 2002).

Mauri and Michaels (1998) researched firm and industry effects not only for a 5-year period, but also for a 15-year period. Their sample consisted of 264 firms in 69 different industries, and used the same firms for the 5-year period (1988-1992) and the 15-year period (1978-1992). The firm and industry effects explained 36.9% and 6.2% respectively of the differences in ROA across firms for the 5 year period, and 25.4% and 5.8% respectively for the 15 year period.

A similar study performed by Misangyi et al (2006) used data for different firms for the years 1984-1999. Their analysis showed a firm effect that explained 36.6% and an industry effect that explained 7.6% of the ROA difference between firms.

Even though the absolute magnitude of the effects differed, in all studies after the one done by Schmalensee the firm effect was found to be at least twice as strong as the industry effect. The dispute about the relative performance of the two therefore seemed to be decided in favour of the firm effect. Eriksen and Knudsen (2003) feared that this conclusion had been made prematurely. In all of the studies the industry and the firm effects were assumed to be independent. They questioned this assumption by pointing at the intuition behind the SWOT framework regarding the analysis of a firm. The strengths and weaknesses are internal to a firm and largely differ between firms. The opportunities and the threats however are mostly the same for firms in the same industry. Because of the idea that firms can turn opportunities which are mostly industry specific into strengths which are mostly firm specific, they decided to add an interaction term for the firm and industry effect to the analysis. They found that there is indeed an interaction effect between the firm and the industry effect, but that this is of limited importance to the overall results. The firm effect again dominated the industry effect, this time by a factor of between 7 and 10.

Hawawini et al. (2003) had doubts in the performance measure used in previous studies. The research on firm and industry effects mostly made use of ROA as the dependent variable but because of this being an accounting measure and different firms might use different accounting principles, they analysed firm and industry effects not only with ROA as a performance measure but also value-based measure like the market-to-book value. This caused no meaningful differences in the outcome of their study. When ROA was used as the dependent variable, the firm effect accounted for 35.8% and the industry effect accounted for 8.1% of the explained variance in form performance. When market-to-book ratio was used as the dependent variable, the firm effect accounted for 32.5% and the industry effect accounted for 11.4% of the explained variance. Even the estimation errors of the models were nearly identical; 51.9% for the market-to-book model and 52.0% for the ROA model.

After the addition of the interaction effect to the analysis Bamiatzi and Hall shifted the focus from the statistical method used to the data used. They noted that, with the exception of Rumelt (1991) and Eriksen & Knudsen (2003), all studies were performed on a sample that consisted mainly of large firms. Although Rumelt's sample also contained small firms, all of these small firms were subsidiaries of large firms. Bamiatzi stated that subsidiaries were not to be compared with independent firms of similar size as they can not be expected to perform identically. A subsidiary could for example enjoy the benefits granted by the scale of their parent, but adequate decision making could also be hampered by the bureaucratic decision-making process in a large firm. The direction of the bias is thus up for discussion but the presence of it seems undeniable (Bamiatzi & Hall, 2009).

Even though the size distribution of firms in the economy as a whole cannot be estimated precisely, their sample of 2 million firms had over 1.7 million with a workforce of less than 10. This to them showed the preponderance of micro firms in the economy and the importance of including these firms in the analysis of performance. They found that the magnitude of firm and industry effects in explaining profitability differed strongly for different definitions of the word industry. If the word industry is defined as all firms in the same sector, they find that the firm effect is between 2 and 3 times as big as the industry effect for micro firms. For small and medium Enterprises (SME's) and large firms however the industry effect is negligible compared to the firm effect.
If the word industry is defined as firms of similar size in the same sector, the results for micro firms do not differ which is unsurprising given their numerical preponderance in the sample. The magnitude of the industry effect increases drastically for SME's and large firms if this definition of industry is used. This implies that when investigating the relative importance of the two effects in explaining the profitability of a firm, the way industry is defined plays a crucial role. The results also showed a significant interaction term between the two effects for all 14 different regressions ran. This confirms the

finding by Eriksen and Knudsen that not only the resources available or the characteristics of the market are important when explaining a firm's profitability. A firm's ability to adapt to these characteristics and make use of the resources will determine whether they will be potentially advantageous or threatening.

Karniouchina et al. (2013) saw another limitation of the samples used by previous researchers. Due to all of the broad samples used, the findings of these studies are all averages across the three different industry life-cycle stages: growth, maturity and decline. Because the within-industry competition differs significantly across the different life cycle stages these averages would not necessarily describe any of the three stages accurately (Miles et al., 1993). Therefore they split up industries according to the stage they were in. Their results were as follows: in the growth stage, the firm effect accounted for 46.14% of the explained variance in ROA whereas the industry effect only accounted for 4.55%. In the maturity stage these numbers were 45.96% and 9.22% respectively and in the decline stage 30.04% and 11.42%. This implies that if an industry progresses in its life cycle, the relative importance decreases for the firm effect and increases for the industry effect. Even in the decline stage however the firm effect was nearly three times as important as the industry effect. In addition to this they found that for the overall sample, meaning that all firms were included regardless of the phase of their industry, the industry effect accounted for 4.2% of the explained variance and the firm effect for 38.46%. The used statistical method, hierarchical linear multilevel modelling (HLM) does not provide any statistical tests to compare the results concerning variance explained. The judgements on whether there were indeed differences between the effects in multiple industry stages are therefore based on subjective judgements by the authors if the differences in variance explained are 'substantial' or not. In their view, the results proved that the industry effect is higher for firms in an industry in the decline stage than in the maturity stage. Furthermore they believed that the industry effect was significantly higher for firms in growing and mature industries than for firms in declining industries.

Author	Method	Industry Effect	Firm effect	Error
Schmalensee, 1985	OLS	18,84%	0,10%	80,89%
	VCA	19,59%	not significant	80,41%
	VCA	19,46%	not significant	80,54%
Rumelt, 1991	VCA	8,32%	46,37%	36,87%
	VCA (& small firms)	4,03%	44,17%	44,79%
Roquebert et al., 1996	VAROCMP	10,20%	37,10%	32,00%
McGahan and Porter, 1997	COV	18,68%	31,71%	48,40%
Mauri and Michaels, 1998	VCA (5-year period)	6,20%	36,90%	56,90%
	VCA (15-year period)	5,80%	25,40%	68,80%
McGahan and Porter, 2002	ANOVA (no correction for serial correlation)	8,90%	32,50%	49,00%
	ANOVA (correction for serial correlation)	10,30%	36,00%	41,70%
Eriksen and Knudsen, 2003	ANCOVA	8,00%	23,10%	38,34%
	ANCOVA	12,10%	37,90%	37,68%
Hawawini et al., 2003	VCA (on ROA)	8,10%	35,80%	52,00%
	VCA (on market-to-book)	11,40%	32,50%	51,90%
Misangyi et al., 2006	HLM	7,60%	36,60%	47,80%
Karniouchina et al., 2013	HLM (Growth stage)	4,55%	46,14%	46,01%
	HLM (Maturity stage)	9,22%	45,96%	31,50%
	HLM (Decline stage)	11,42%	30,04%	33,19%
	HLM (full sample)	4,20%	38,46%	41,84%

Table 1: Results from previous studies on the importance of industry effects and firm effects on firm performance. The percentages displayed represent the proportion of explained variance. The notable pattern is that the industry effect is smaller than the firm effect in all studies except for the one performed by Schmalensee in 1985.

		Industry = entire sample	Industry = similar sized firms
Micro firms	Firm effect	0.7	0.708
	Industry effect	0.252	0.21
	Interaction effect	0.199	0.141
Small & Medium Firms	Firm effect	0.477	0.489
	Industry effect	0.081	0.269
	Interaction effect	0.199	0
Large Firms	Firm effect	0.0645	0.704
	Industry effect	0.056	0.083
	Interaction effect	0.215	0

Table 2: results from the study done by Bamiatzi and Hall (2009). The results show that the industry effect differs depending on the definition of the word industry. If industry is defined as firms of similar size in the same sector, the industry effect increases for SME's and large firms compared to when the word industry is defined as firms in the same sector.

2.3 What is an economic crisis and how can it impact firm performance?

Previous research on firm performance has focused on full business cycles, split up firms and industries according to size and studied firm performance in the different life cycles of industries. No research has been done yet on the effect of an economic crisis on firm performance.

A recessionary period and the decline stage of an industry have some things in common such as stagnation of demand and increased scarcity of resources. Despite this findings on industrial cycles can not be generalised to economic cycles. The reason for this is that the life cycle of an industry is a form of endogenous uncertainty and even to some extent predictable (Garcia-Sanchez et al., 2014). In contrast, economic cycles are a lot more turbulent by nature and have less predictable periodicity, they are a form of exogenous uncertainty (Mascarenhas & Aaker, 1989).

To answer this question I will shortly explain what happened during the 2007-2009 economic crisis and then go over the possible implications this might have had for firm performance according to the literature.

2.3.1 Short summary of the Economic Crisis

Diamond (1984) described the role of bankers to be an intermediary position between depositors and borrowers. Depositors store their money at a bank and banks use these funds to loan to borrowers. The bank assesses the credit-worthiness of their clients and ask for a risk-corresponding interest rate on the money they loan out. The loans are considered to be assets because the bank has the legal right to get them back from the borrowers. The deposits are considered to be liabilities because these must be returned to the depositors upon demand. To avoid the risk of being unable to return these deposits a bank must always keep a certain percentage of the deposits in cash. This is where it went wrong.

In the years leading up to 2007, the real estate prices in the United States skyrocketed. Between 2002 and 2007 the house prices increased by 11% each year, a magnitude that had not been seen before. The majority of these houses was bought with borrowed money as can be seen from the ratio of debt to national income. This ratio increased from 3.75:1 to 4.75:1 in these years (Acharya & Richardson, 2009). To protect themselves against the risk of all depositors withdrawing funds from the bank at the same time, as seen before during the Great Depression, banks should have held a sufficient amount of cash. Due to various reasons that can be read in the Financial Crisis Inquiry Report the banks failed to do this and thereby put themselves and the depositors at a risk of illiquidity (Financial Crisis Inquiry Commission, 2011). This caused problems when the delinquency rate of loans began to increase from the second quarter of 2006 onwards (Board of governors of the Federal Reserve System, 2018). Large companies such as Freddie Mac and Lehman Brothers that invested in securities based on these mortgages defaulted, causing great concerns which led to a sharp stagnation of capital markets worldwide.

2.3.2 Core Numbers of the Economic Crisis in the UK

Due to the global character of the modern economy the crisis spread quickly. In the United Kingdom the domestic lending of banks decreased by over 15% in the period between the end of the first quarter of 2008 and the third quarter of 2009 (Acharya & Richardson, 2009). This meant that firms could borrow less money to fund new investments and research and therefore this led to an even stronger stagnation of the economy. At its peak (or valley) the GDP decreased by 2.2% in just one quarter. This was the fourth quarter of the year 2008, immediately after the fall of Lehman Brothers in the United States. Between 2007 and 2009 the real GDP per capita decreased by a total of 6%.

2.3.3 Possible implications

Economic crises have historically been associated with periods of poor firm performance (Richardson et al., 1998). There are two main reasons to believe that in a period of poor firm performance such as the 2007-2009 crisis, the importance of the industry effect may change.

First of all, the way firms or industries are affected by a decline in lending such as the one in 2008 and 2009 is not universal. Using data for 28 manufacturing industries in over 100 countries for the years 1963-1999 Braun and Larrain (2005) discovered a negative relationship between an industry's degree of dependency on external funding and output growth in recessions. In other words, they found the intuitive result that an industry that makes more use of borrowed money is hit harder by a decline in opportunity to borrow this money. In addition to this the results showed that industries in which intangible assets such as brand name and knowledge make up a larger part of the total assets also suffer more severely during recessions. Dell'Arricia et al. (2008) continued on these results and wanted to add two extra dimensions to the research. While Braun and Larrain found inter-country effects, they did not look at within-country effects. The added relevance of this specification is that if you look at within-country effects only, structural differences in capital markets between countries can no longer influence the results and this would lead to a more accurate determination of the effects of a stronger dependency on external funding during recessions. Once more the results were that sectors that were more dependent on external financing were impacted more negatively by a banking crisis and the corresponding decline in lending. On top of this Dell'Arricia et al. investigated whether there are differences of industry growth rates in recessions depending on the size of the firms in the industries. They found that if an industry consists of bigger firms, this industry is less affected by a banking crisis.

The second reason to believe that the relative importance of the industry and firm effect may have changed during the crisis is down to consumer demand. We have seen that both the GDP and the real GDP per capita decreased during the crisis. A common way to describe a consumer's behaviour change to a bigger scarcity of money is the income elasticity of demand of a certain good. The income elasticity of demand gives the percentage change in demand for a good given a one percentage change of income. Houthakker (1957) found some regularities in income elasticity of demand across industries. First of all he found that the income elasticity of demand for food never exceeds unity. This is known as Engel's law and means that if a consumer's income changes, the fraction of the income spent on food changes less severely. The same pattern was found for expenditures on housing, also known as Schwabe's law. The income elasticity of demand on clothing however is usually found to be larger than one (Ohidul Haque, 2005). The general thought behind this is that housing and food are products that every individual needs to reach a basic standard of living and therefore the expenditures on this are less sensitive to income changes than the expenditures on new clothes, as these are often seen as superfluous to the clothes one already has.

The industry effect is not the only aspect of firm performance that might change however. Economic crises are known to be detrimental for the performance of firms and therefore it might be true that only the strongest firms can survive such periods. In the previously named study by Garcia-Sanchez et al. (2014) economic shocks are described as a natural cleansing mechanism of the market that gets rid of the bad firms that are not able to protect against these changes in the market. Therefore only the good firms with high level of knowledge, technology and flexibility remain. Especially the last aspect, financial and strategic flexibility, was emphasised by the authors as flexibility allows a firm to adequately react to the scarce growth opportunities that present themselves in tough economic times. Traditions are useful for a firm as it creates reliability, but in times of economic crises these traditions can cause rigidity and resistance to chance. Therefore the strongest and even the most traditional firms are incentivised to break traditions and realign their resources in order to make it through the economic crises as good as possible.

2.4 Hypotheses

Previous research has pointed out that the effects of an economic crisis vary among different industries depending on for example industry's firm's dependency on external financing and the character of the goods produced by the industry. If the goods are primary goods necessary to reach a basic standard of living, the reduction in total sales is lower than for luxury goods for a given reduction in consumer income. The observation that the magnitude of the impact of a recession is largely industry specific leads to the following hypothesis:

Hypothesis 1: *The magnitude of the industry effect in explaining firm performance was higher during the economic crisis than in the years before.*

This hypothesis can be seen as a hypothesis in favour of the industry based view. A case can also be made for the resource-based view or the firm based view however. Garcia-Sanchez et al. (2014) state that economic shocks are a natural cleansing mechanism of the market from bad firms that are unable to adapt to a changing economic environment. Only the strongest firms are expected to survive the crisis. This leads to the following hypothesis:

Hypothesis 2: *The magnitude of the firm effect in explaining firm performance was higher during the economic crisis than in the years before.*

In the following sections these two hypotheses will be tested using quantitative data.

3. Data

The data section of this research will contain information on what kind of data will be used and where this data is retrieved from. All modifications to the original dataset are explained to facilitate replication of this study. In addition to this, the key concepts will be defined unambiguously for this same purpose. Lastly, a number of summarising statistics will be shown to give a quick insight in the data.

3.1 Data retrieval and modification

All data is drawn from the Compustat Global - Capital IQ database, accessed using the WRDS research platform. Compustat contains financial statement information on 99,000 securities worldwide. Annual firm data is available for the period 1950-2019. From this database, data was requested on UK-based firms for the years 2004-2009. The firm data requested was the global company key (gvkey), four-digit SIC industry code, total assets and net income per fiscal year. Firms of all sizes were included in this sample.

All firms that did not include data for the full 2004-2009 period were excluded. For the purpose of this research multiple firms per industry are needed and therefore all firms active in an industry with less than four firms in this database were removed from the sample as well. Finally, two firms were excluded from the sample as their fiscal years changed during the 2004-2009 period resulting in unreliable data. This resulted in a final sample of 1032 firms active in 92 different industries.

Because the database did not contain all variables needed for the study, two have been added manually. The first manually added variable is the return on assets variable. This is calculated by dividing the net income of the firm in a year by the total assets the firm possessed at the end of that year. In formula:

$$FRoa_{(i,t)} = \frac{Ninc_{(i,t)}}{TA_{(i,t)}}$$

Here $Ninc_{(i, t)}$ is the net income for firm i in year t and $TA_{(i, t)}$ is the total value of firm i's assets at the end of year t.

The second manually added variable is the average return on assets per firm in an industry. This is calculated by adding up the return on assets for all the firms in that industry in that year and then dividing by the number of firms in that industry. In formula:

$$IRoa_{(j,t)} = \frac{\sum_{i=1}^{k}\left(FRoa_{(i,t)}\right)}{k_j}$$

Here k_j is the total number of firms in industry j.

3.2 Definition of key words

Industries are defined and categorised using the four digit Standard Industrial Classification (SIC) code system. SIC codes are numerical codes assigned to industries by the government of the United States to facilitate the collection and analysis of financial data. The four digit SIC code has been preferred over the two- and three digit codes due to their more detailed classification of industries. Because our sample contains micro firms and micro firms are more likely to be active in a niche market, categorising them based on the more general two- or three digit codes would be less appropriate as pointed out by Chang and Singh (2000).

Total assets is comprised of current assets, net property, plant, equipment plus other non-current assets including intangible assets, deferred charges, investments and advances.

Net income is the income reported by a company after all expenses have been deducted from the revenues of the fiscal period, including extraordinary items and discontinued operations

3.3 Summarising statistics

Table 3 shows the summarising statistics for the data sample. A few of these results are noteworthy. Firstly, the average return on assets per firm is negative for the full sample, but is more negative during the years of the crisis than the years before the crisis. The same pattern is seen for the average return on assets per firm in an industry.

Secondly, we can see that the lowest observation for return on assets was made for the years of the crisis, namely -73.179. At the same time we can see that the highest observation for return on assets was also made during the crisis, which is not necessarily the first thing one would expect.

Lastly we see that the standard deviation for firm performance is higher during the crisis than before the crisis, whereas the standard deviation for industry performance is lower during the crisis than before the crisis. This means that the average performance per firm per industry was less spread out during the crisis than before the crisis and that the average firm performance was more spread out during the crisis. This might be seen as a slight indication that the firm effect might have increased and the industry effect might have decreased in the crisis.

	Observations	Mean	Standard error	Minimum	Maximum
Firm Roa	6,192	-0.102	1.212	-73.179	1.848
Firm Roa before crisis	3,096	-0.064	0.769	-25.285	0.728
Firm Roa during crisis	3,096	-0.141	1.541	-73.179	1.848
Industry Roa average per firm	6,192	-0.148	1.292	-39.89	0.177
Industry Roa average per firm before crisis	3,096	-0.14	1.77	-39.89	0.158
Industry Roa average per firm during crisis	3,096	-0.155	0.459	-5.949	0.177

Table 3: Summarising statistics of the data sample

4. Methodology

4.1 OLS assumptions

In order for an ordinary least squares (OLS) regression to be a valid way to conduct the relationship between a dependent variable and some independent variables, five assumptions must be satisfied. In the next section only the assumptions that are expected to be violated in this research will be mentioned. The other assumptions can be found in the appendix section on regression diagnostics.

Assumption 2: $Var(u_i) = \sigma^2 < \infty$

This assumption is known as the assumption of homoscedasticity. It means that the variance of the estimation errors is assumed to be constant. To test whether this is the case one can make use of numerous tests, among which the White test for regular data and a modified Wald test for panel data, which is the one that will be used. If there is indeed heteroscedasticity, this can be solved by using heteroscedasticity-robust standard errors.

Assumption 3: $Cov(u_i, u_j) = 0 \; for \; i \neq j$

This assumption states that the error terms are not correlated with each other. In other words, there can not be autocorrelation between the estimation errors. This can be tested for by using the Wooldridge test. If the errors are indeed correlated, this can be solved by clustering the errors in groups within which they are correlated.

Assumption 4: $Cov(u_t, x_t) = 0$

This means that the error terms can not be correlated with the independent variables, they have to be exogenous. If there turns out to be correlation, meaning that the model suffers from endogeneity, this can be addressed in multiple ways. In a dynamic panel data model this can be solved by using the Arellano-Bond method.

If all of the assumptions are satisfied, this means that the OLS regression is BLUE. This is an acronym for **b**est **l**inear **u**nbiased **e**stimator. According to the Gauss-Markov theorem, if OLS is blue it will have the minimum variance among the class of linear unbiased estimators and will therefore be the most efficient of its kind (Wooldridge, 2014).

4.2 Panel regression

The first regression will be ran on panel data. Panel data is data containing both a time series element and a cross sectional element. This adds some complications. First of all, the homoscedasticity assumption is likely to be violated as there is data of different entities across different time periods. Secondly, there will most likely be autocorrelation between the errors as there will be successive observations of the same entity. A(n unobserved) characteristic that will influence a firm's performance in 2004 will most likely also influence the firm's performance in 2005. Therefore we cannot assume that observations are independent of each other. In case of a static panel model, meaning that none of the independent variables is a lagged value of the dependent variable, these effects can be filtered out using a fixed effects or a random effects model.

Due to the fact that the firm effect is operationalised as a measure of past firm performance combined with the fact that the dependent variable in this study is firm performance, the model used will not be a static model but a so called dynamic panel data model. A dynamic panel data model is a model in which one of the independent variables is the lagged value of the dependent variable. This violates the assumption of strict exogeneity, rendering the use of the fixed effects or random effects models invalid. A common way to address this in dynamic panel data models is by using the Arrelano-Bond method (Arellano & Bond, 1991). This method uses deeper lags of the dependent variable as instruments for the lagged variable that is causing the endogeneity. For the other independent variables the first differenced value is used as an instrument.

The Arellano-Bond method will be used to estimate the following regression equation using the data of the full 2004-2009 period.

$$FRoa_{(i,t)} = \alpha + \beta_1 FRoa_{(i,t-1)} + \beta_2 IRoa_{(j,t-1)} + \beta_3 Dummy * FRoa_{(i,t-1)} + \beta_4 Dummy * IRoa_{(j,t-1)} + \beta_5 FRoa_{(i,t-1)} * IRoa_{(j,t-1)} + \varepsilon$$

where:

- α = constant
- $FRoa_{(i,\, t)}$ = Return on assets for firm i in year t
- $IRoa_{(j,\, t)}$ = Average return on assets per firm for industry j in year t
- Dummy * $FRoa_{(i,\, t-1)}$ = a dummy variable that takes value 0 for the years 2004-2006 and value 1 for the years 2007-2009 multiplied by the return on assets for firm i in year t-1 (firm effect)
- Dummy * $IRoa_{(j,\, t-1)}$ = a dummy variable that takes value 0 for the years 2004-2006 and value 1 for the years 2007-2009 multiplied by the average return on assets per firm for industry j in year t-1 (industry effect)
- $FRoa_{(i,\, t-1)}$ * $IRoa_{(j,\, t-1)}$ = the interaction effect between the firm effect and the industry effect
- ε = error term

This is a panel data regression with an added dummy variable that has the value 1 for the years 2007-2009 and 0 for the years 2004-2006. Using this dummy two new interaction variables were created: one in which the dummy is multiplied by the industry effect variable, and one in which the dummy is multiplied by the firm effect variable. If either of these combined variables has a significant coefficient in the regression analysis this would confirm the idea that the corresponding effect has changed for the years of the crisis. The regression also contains an interaction variable of the firm effect and the industry effect.

Regarding the possible violation of the previously mentioned assumptions for OLS, two additional tests will be performed. The first of those will test for heteroscedasticity of the errors using the modified group Wald test.

The second test will check for autocorrelation in the errors. If there appears to be a higher order or autocorrelation than 1, the Arellano-Bond regression has to make use of even deeper lags as instrumental variables.

4.3 Cross sectional regression

In addition to this, a set of cross-sectional regressions using only part of the full sample will be ran. These regressions look the following:

$$FRoa_{(i,t)} = \alpha + \beta_1 FRoa_{(i,t-1)} + \beta_2 IRoa_{(j,t-1)} + \beta_3 FRoa_{(i,t-1)} * IRoa_{(j,t-1)} + \varepsilon$$

In contrast to the previous regression this regression will only be ran for the years t = 2006 and t = 2009. Here the year 2006 is taken to represent the pre-crisis period as it is the last year before the crisis. This minimises the possible changes in firm and industry effects that are independent of the crisis. The year 2009 is chosen to represent the crisis. These years will be examined separately and therefore this is a cross sectional regression and not a panel regression. The time series dimension is omitted due to the regression being ran on one year at the time. This means that the estimations will not have to be tested for autocorrelation in the errors. The possibility of the errors being heteroscedastic still exists however and therefore this will be tested for using the combined Breusch-Pagan and Cook-Weisberg test.

The coefficients for these two regressions will then be compared and checked for any structural changes. If the importance of the industry effect has indeed changed in the economic crisis, we would see a significantly different β_2 in the 2006 regression to the one in the 2009 regression. This will be statistically tested by using seemingly unrelated estimations to compare the coefficients. The difference between running seemingly unrelated estimations (SUE) and running two regressions *equation-by-equation* (EBE) is that in EBE the estimation errors are assumed to be uncorrelated between observations. In SUE we allow for correlation between the errors.

5. Results and discussion

5.1 Panel data regression

Before running the Arellano-Bond regression on the panel data a specification of the appropriate standard errors is required. As stata does not contain an option to check for heteroscedasticity in an Arellano-Bond regression, a different approach is taken. The heteroscedasticity test is done for how the model would look like if the lag of the dependent variable is not included. As can be seen in appendix table A, the null hypothesis of homoscedasticity is rejected using the modified Wald test for panel data models. Therefore robust standard errors are used in the regression.

	Model 1 $FRoa_{(i, t)}$	Model 2 $FRoa_{(i, t)}$	Model 3 $FRoa_{(i, t)}$
$FRoa_{(i, t-1)}$ (= Firm effect)	-0.174^{*}	-0.040	-0.347^{*}
	(0.091)	(0.027)	(0.185)
$IRoa_{(j, t-1)}$ (= Industry effect)	0.010	-0.108	-0.108
	(0.009)	(0.082)	(0.084)
Dummy * $FRoa_{(i, t-1)}$ (= additional firm effect during crisis)		-0.442^{***}	-0.354^{*}
		(0.171)	(0.208)
Dummy * $IRoa_{(j, t-1)}$ (= Additional industry effect during crisis)		0.120	0.086
		(0.081)	(0.080)
$Froa_{(i, t-1)}$ * $IRoa_{(j, t-1)}$ (=Interaction effect)			-0.200^{*}
			(0.119)
Constant	-0.112^{***}	-0.129^{***}	-0.139^{***}
	(0.021)	(0.022)	(0.023)

Table 4: step by step construction of the panel data regression model. All regressions are performed using the Arellano-Bond method. Standard errors in parentheses * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. In the third and complete model the firm effect is statistically significant. In addition to this the additional firm effect during the crisis is statistically significant and negative, meaning that the firm effect was lower during the crisis than before. For the industry effect no difference is detected between the pre-crisis period and the crisis period.

In table 4 the results of three different panel regressions are shown. The first model only makes use of the firm effect and the industry effect variable to explain firm performance. In the second model the dummy firm effect and dummy industry effect variables are added to distinguish the pre-crisis effects from the effects during the crisis. In the third and last model a variable capturing the interaction effect of the industry and firm effect is added. In order to use these variables and interpret their coefficients they need to be statistically significant. If a variable is not significant, this means that although their coefficient might not be exactly zero, the difference is statistically negligible. If a zero was used in the fitted regression instead of the estimated value, the dependent variable is assumed to be unaffected. If a variable *is* statistically significant, the value of their coefficient is distinguishable from zero and can therefore be meaningfully interpreted (Brooks, 2014).

All models also have a variable named constant. The interpretation of the constant in a regression is requires an additional criterion to the previously explained significance criterion. This additional criterion is that it the numerical value of the coefficient can only be interpreted if a situation where the value of all the different variables is zero is plausible. In our models this is not plausible and therefore the constant will not be discussed any further.

In the first model the firm effect variable is statistically significant and can therefore be interpreted. The coefficient of -0.174 means that if the return on assets of a firm increases by 1 British pound in a given year, this will on average decrease the return on assets of that firm by 0.174 British pounds in the year that follows. The noteworthiness of this result is that is seems to imply that if a firm performs well in one year, this will have a negative impact on the performance of the following year. The industry effect has a positive coefficient of 0.010, however due to the statistical insignificance of this coefficient no interpretation can be done.

Put differently, by analysing Model 1 we can answer the question "*What is the value of the firm effect and industry effect for the years 2004-2009".* However, the aim of this study was to find a possible change in these two effects for the years of the crisis compared to the years before the crisis. In Model 2 two new variables are added in order to detect such a possible change. The first is an interaction variable between a dummy variable and the firm effect. The second is an interaction variable between a dummy variable and the industry effect. In both cases the dummy variable is a variable that takes value 0 for the years 2004-2006 which is the pre-crisis period, and value 1 for the years 2007-2009 which is the crisis period. This alters the way of interpreting the results of the regression slightly. The first two variables of the model now only show the coefficients for the years in which the dummy variable equals 0. This means that the firm effect variable now only shows the firm effect for the years 2004 to 2006. To determine the firm effect for the years after this, the coefficient of the dummy interaction variable ought to be added to this.

In the case where both the firm effect variable and the dummy interaction firm effect variable are statistically significant, the firm effect for the year 2009 would have been-0.040-0.442. In this model the firm effect variable is not significant however and therefore this interpretation is not valid.

Model 3 contains another new variable. This variable captures the interaction effect between the firm effect and the industry effect. This allows the impact of the firm effect on firm performance to differ depending on the magnitude of the industry effect. Likewise it allows the impact of the industry effect on firm performance to differ depending on the magnitude of the firm effect. The statistical significance of this interaction effect confirms the results of Knudsen and Eriksen (2003). Due to this being the full model, now a full interpretation of the firm and industry effects can be done. The *regular* firm effect variable has a statistically significant coefficient of -0.347. This means that the return on assets of a firm in the pre-crisis period decreases by 0.347 British pounds on average if the return on assets in the preceding year was 1 pound higher. This is a direct effect. However there is also an indirect effect due to the interaction effect variable. By increasing the return on assets by 1 British pound, the return on assets in the following year is also influenced due to the changing impact of the industry effect. The sign and magnitude of this indirect effect depends on the sign and value of the industry effect and therefore differs for each individual firm. The regression output shows the interaction effect for a so called average firm with an average return on assets in an average industry. For such a firm the indirect effect of a 1 British pound increase of return on assets would increase the return on assets of the following year by 0.03 British pounds. This effect is relatively small compared to the negative influence of the firm effect mentioned previously.

The interaction variable of the dummy and the firm effect is statistically significant meaning that the firm effect before the crisis differed from the firm effect during the crisis. The coefficient has value -0.354 meaning that a firm's return on assets in the crisis period will on average decrease by 0.701 British pounds (which is 0.347+0.354) if the return on assets in the preceding year was 1 pound higher. Again, there is an indirect effect that is dependent on the magnitude and sign of the industry effect. For an average firm with an average industry return on assets per firm, an increase of 1 British pound in the firm's return on assets will lead to a 0.03 British pounds increase in the return on assets the next year as illustrated in the previous paragraph. Due to both the industry effect and the interaction variable of the dummy variable and industry effect being statistically insignificant, the industry effect can not be interpreted numerically.

Using the third model, being the most complete model, the hypotheses concerning a change in the magnitude of the firm effect and/or industry effect during the crisis can be tested if the model is valid. The Arellano-Bond model is valid in case there is no autocorrelation in the first-differenced residuals of order 2. The results of the Arellano-Bond test can be seen in table 5.

Autocorrelation order	Z-value	P>z
1	-0.785	0.433
2	-0.644	0.519

Table 5: Results of the Arellano-Bond test for zero autocorrelation in first-differenced errors for model 3.

These results imply no second-order autocorrelation in the first differenced errors in the model and therefore this model can be used to test the hypotheses.
As previously mentioned, the interaction variable of the dummy variable and the industry effect was statistically insignificant. This means that the results show no evidence of a difference in the industry effect variable before the economic crisis compared to the industry effect variable during the economic crisis. Therefore the first hypothesis, stating that the industry effect would be higher during the economic crisis, is rejected.

The interaction variable of the dummy variable and the firm effect variable was statistically significant. This implies a different pre-crisis firm effect variable compared to the firm effect variable during the crisis. The coefficient was negative however, meaning that the firm effect was lower during the crisis than before the crisis. Therefore the second hypothesis, stating that the firm effect would be higher during the crisis, is also rejected.

5.2 Cross-sectional regression

A second way to address the question whether the firm and industry effects changed during the crisis is by running two separate regressions, one for the year 2006 and one for the year 2009. This is done using the seemingly unrelated estimations method specified in the methodology section. Again the errors were tested for heteroscedasticity in order to know the correct standard errors to use. This is done using a combined Breusch-Pagan and Cook-Weisberg test for homoscedasticity. The outcome of this test, showing that heteroscedasticity robust standard errors are needed in both years, can be seen in appendix table B.

The results of the seemingly unrelated estimations for both years can be found in table 6 below. The model's performance is measured by the R-squared coefficient and the adjusted R-squared coefficient. The R-squared measures how much of the total variance of the dependent variable is explained by the independent variables. The model for 2006 has an R-squared value of 0.1608, which means that 16.08% of the observed variance in firm performance in 2006 can be explained by the model. For the 2009 the R-squared value is 0.1116 meaning that 11.16% of the observed variance can be explained by the model. One downside to the R-squared is that no matter how many variables are added to the model it will never decrease. There might be numerous irrelevant variables in the model while the model still has a high R-squared value. To solve this the adjusted R-squared is used. The adjusted R-squared punishes, so to speak, a model for including variables that have a low contribution to the R-squared value. The adjusted R-squared for the 2006 model is 0.1584 and the adjusted R-squared for the 2009 model is 0.1090. We can see that these values are only marginally lower than the R-squared values, meaning that the model does not suffer from a number of irrelevant variables.

By analysing the results of the 2006 regression and comparing those to the results of the 2009 regression, the hypotheses of the research can be tested once more. In 2006 both the firm effect and the industry effect coefficients were statistically significant, allowing us to interpret their values. The firm effect had a coefficient of 0.611. The interpretation of this is similar to what we have seen for the panel data regressions. If the ROA of a firm in 2005 was one pound higher, the ROA of that same firm in 2006 would increase by 0.611 pounds on average. The coefficient of the industry effect was 0.232, which can be interpreted as saying that when the average ROA per firm in an industry increased by one pound in 2005, the ROA of a firm in that industry in 2006 increases by 0.232 pounds on average.

The results for 2009 show some changes. Firstly, the firm effect coefficient has changed from a positive 0.611 to -0.522, both statistically significant. Interpreting the 2009 coefficient shows the same relation as seen in the panel data regression. If a firm's ROA in 2008 increases by 1 pound, the firm seems to get punished for this by a decrease in its 2009 ROA of 0.522 pounds.

The industry effect coefficient has increased from 0.232 in 2006 to 0.689 in 2009. The latter of these coefficients is not statistically significant however and can therefore not be interpreted meaningfully.

For both years the interaction effect has a statistically significant coefficient, again confirming the results of Eriksen and Knudsen's research from 2003.

	Model 4: ROA 2006	Model 5: ROA 2009
$FRoa_{(i, t-1)}$ (= Firm effect)	0.611***	-0.522*
	(0.114)	(0.311)
$IRoa_{(j, t-1)}$ (= Industry effect)	0.232***	0.689
	(0.087)	(0.884)
$Froa_{(i, t-1)}$ * $IRoa_{(j, t-1)}$ (=Interaction effect)	0.676***	-1.094**
	(0.195)	(0.518)
Constant	-0.014	0.068
	(0.013)	(0.126)
R-squared	0.1608	0.1116
Adjusted R-squared	0.1584	0.1090

Table 6: Results from the seemingly unrelated estimations. Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The dependent variable of Model 4 is a firm's return on assets for 2006 and the dependent variable of Model 5 is a firm's return on assets for 2009. The firm effect coefficient for the 2006 model is higher than for the 2009 model. This implies a change of the effect during the crisis. The Industry effect coefficient is lower for the 2006 model than for the 2009 model.

To be able to address the hypotheses and answer the main question of the study, the coefficient changes have to be tested statistically. This is done using the Wald test which can be seen in table 7. The Wald test shows no significant change in the industry effect coefficient from 2006 to 2009. The change of the coefficient seen in the regression results may have been offset by the fact that the standard error of this coefficient is more than ten times higher. This shows that the coefficient estimate was higher, but at the same time a lot more inaccurate. As there seems to be no significant coefficient change for the industry effect, the results imply a rejection of hypothesis 1.

The Wald test does show a significant change in the firm effect coefficient. Like in the panel data regression, this change is downward and not upward. Therefore the results again lead to a rejection of hypothesis 2, stating that the firm effect would be higher during the crisis than before the crisis.

	Chi-Squared value	P> Chi-squared
Industry effect 2006 = Industry effect 2009	0.27	0.607
Firm effect 2006 = Firm effect 2009	10.5	0.001

Table 7: Results from the Wald test on equality of coefficients. Null hypotheses are displayed in the leftmost column. The tests show a significant difference between the firm effect coefficient in the 2006 model and the 2009 model. For the industry effect no such difference is found.

5.3 Discussion

Found results are not always in line with the results of previous research. In this section the main differences and similarities between this research and the researches discussed in the theoretical framework will be mentioned.

The performance of the Arellano-Bond method can not be described by the (adjusted) R-squared coefficient which makes comparison with previous studies difficult. The seemingly unrelated estimations' performance can be captured by the (adjusted) R-squared method however. In this study the values of the R-squared and he adjusted R-squared of the 2006 and 2009 regressions all were between 10.9% and 16.08%. This is not considered to be extraordinarily low. The research done by Eriksen and Knudsen (2003) for example consisted of 5 different models, 4 of which had an R-squared or adjusted R-squared in that range. The last model had an even lower R-squared. It is considered to be on the lower side however as there are many studies with substantially higher model performance. An example of this is the study done by Bamiatzi and Hall (2009) which conducted 7 different types of regressions, 6 of which had an adjusted R-squared value higher than 0.3.

For both the panel data regressions and the cross sectional regressions the significance of the coefficients of the firm and industry effects was at least partly inconsistent with previous studies. In this study, the firm effect was statistically significant in all cases, as was the interaction effect, but the industry effect was insignificant more often than not. In most previous studies, such as the one done by Karniouchina et al. (2013), all of the found results were statistically significant. There are multiple possible reasons for this.

One of these is that some studies, such as the one by Karniouchina et al., set certain benchmarks during the sample selection. An example of this is that they only included firms if the yearly turnover was higher than a certain minimum amount. This way the sample becomes more homogeneous.

The signs and magnitude of the firm and industry effects are the third point of comparison. In the panel data regressions the industry effect had a negative coefficient, implying that a higher firm performance in one year would negatively impact the firm performance in the next year. The same was found for the cross sectional regression in 2009. This stands in contrast with Bamiatzi and Hall's (2009) results, where the coefficients were found to be positive without exception. Results of the 2006 regression did follow the pattern of previous research, with positive coefficients for the firm and industry effects and the firm effect outweighing the industry effect by a factor of between 2 and 3.

A possible reason for both the low R-squared coefficients in this research compared to earlier ones and the insignificance of the industry effect may be the size of the sample. The sample consisting of 1032 firms is small compared to the nearly 70,000 in the sample used by Bamiatzi and Hall (2009). A smaller sample uses less data points and therefore is more sensitive to outliers. On top of this some industries in the sample only consisted of four firms. These four firms might mispresent the industry and therefore the industry effect might not be correctly captured in the model.

6. Conclusion

The main aim of this research was to answer the question: "What happened to the magnitude of firm and industry effects for UK firms during the 2007-2009 crisis?". Three sub questions were used to aid in answering this.

The first sub question concerned the definition of the word firm performance. The literature showed a development in the theoretical definition, however this did not seem to affect the quantitative or practical definition of firm performance. Ever since the earliest research on the topic, performed in 1985 by Schmalensee, the vast majority of studies have used return on assets (ROA) as the definition of firm performance.

The second sub question concerned the definition of the concepts of industry effect and firm effect and their role in explaining firm performance. With firm effects strategy literature mean effects on a firm's performance caused by firm specific characteristics such as brand name. In quantitative research this is often operationalised by a form of past firm performance. Industry effects comprise effects on a firm's performance that are industry specific, such as bargaining power of suppliers. This is often operationalised by a form of past industry performance. In all the studies conducted after Schmalensee's first (1985) the firm effect has been larger than the industry effect.

The third sub question concerned the possible implications of an economic crisis on firm performance. Analysis of previous research led to two hypotheses. The first hypothesis was: The magnitude of the industry effect was higher during the economic crisis than the years.

The second hypothesis was: The magnitude of the firm effect was higher during the economic crisis than in the years before.

These hypotheses were tested using UK firm data for the period 2004-2009. Neither panel data regressions nor cross sectional regressions found any indication for an increase of the firm effect or the industry effect during the economic crisis. Both hypotheses were therefore rejected.

The answer to the main question has to be split up in two parts. The first part examines the firm effect. The panel data regression showed a lower firm effect during the crisis compared to before the crisis. Cross sectional examination of firms for the years 2006 and 2009 confirmed these results. The conclusion regarding firm effects therefore is that firm effects explaining firm performance were lower during the crisis than before the crisis.

The second part examines the industry effect. Neither panel data regressions nor cross sectional regressions implied any change in the magnitude of the industry effect on firm performance. The conclusion regarding industry effects therefore is that industry effects explaining firm performance have not changed during the crisis.

6.1 Limitations

Like all other researches this research also has stronger and weaker points. These weaker points may be a good reference point for future research on the topic. A weaker point to start with is the size of the database. Due to the sample size being small relative to previous researches some industries in the sample only consisted of four firms. This may have caused a bias. One example of why this is, is the following. The regressions looked for possible influence from both return on assets of a firm in the year t-1 and industry average return on assets per firm in the year t-1 on return on assets of a firm in year t. However, if a firm is active in a small industry, the return on assets of that firm might well have influenced the industry average return on assets per firm. This may cause results to be unreliable. One possible way to solve for this is by not simply using the return on assets of the past year to represent the firm effect, but to use the average of multiple years, as was done by Bamiatzi and Hall (2009).

Secondly, the sample used only contained firms that were based in the United Kingdom. Therefore the results are only externally valid insofar the market in the United Kingdom can be compared to different countries. Future research might investigate whether the results in this study are consistent with results for studies concerning different developed countries, such as the United States of America or even developing countries such as Brazil.

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8. Appendix

	Value
Chi^2(1032)	3.3 * 10^10
P>Chi^2	0.000

Appendix table A: Results from the wald test on groupwise heteroscedasticity. Null hypothesis: variance of standard errors is constant between observations. Alternative hypothesis: variance of standard errors standard errors is heteroscedastic.

	Chi^2 (1)	P>Chi^2
2006	575.82	0.000
2009	2716.40	0.000

Appendix table B: Results from the combined Breusch-Pagan and Cook-Weisberg test on heteroscedasticity of errors. The lefternmost colum displays the year for which the errors were tested. Null hypothesis: variance of standard errors is constant between observations.

Appendix: Regression Diagnostics

In this section the last two assumptions of OLS regressions are explained. These two assumptions are not relevant to be tested for this research and are therefore not included in the main text.

Assumption 1: $E(u_t) = 0$

This assumption means that the average value of the errors is zero. This assumption is not expected to be violated as including a constant term in a regression will ensure this assumption is not violated

Assumption 5: $u_t \sim N(0, \sigma^2)$

This means that the error terms have to be normally distributed with a mean of 0. For large samples violation of this assumption has negligible consequences due to the central limit theorem (Brooks, 2014).