Three Essays on Economic Uncertainty & Business Decisions

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I dedicate this thesis

to my wife Zoi and my children

Foteini, Evgenia and Georgia-Emmeleia

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Abstract

We examine the effects of uncertainty on investment and profitability of the Greek firm. We employ panel data from 25000 Greek firms' balance sheets over a 14-year time window that covers the period before and after the eurozone crisis. A dynamic factor model is used to construct the uncertainty proxy measure. The impact of uncertainty on business decisions is revealed by using a dynamic model and a panel quantile estimation framework. The results indicate that uncertainty affects business decisions negatively. However, the negative effect depends on the size of the firm and on the quantile classification. Both of the models reveal a high degree of heterogeneity among sectors of economic activity in Greece.

Chapter 1

Introduction

The economic crisis of 2007-2008, the most severe since the Great Depression, triggered the start of a decade of financial slowdown, economic instability and economic uncertainty. Concerns about the magnitude of the uncertainty effects on business decisions have intensified and questions about its role have captivated economists, politicians and decision makers. Greece was one of the most affected countries of the eurozone crisis, it faced the risk of default and presents a clear example for the impact that uncertainty can have on firms and enterprises.

In this thesis we attempt to empirically investigate the extent at which economic uncertainty in Greece affects firms investment and profitability rates. The literature of investment under uncertainty is very rich. On the other hand the literature of profitability under uncertainty is quite limited. The empirical results suggest that the effect of uncertainty is negative while the theoretical literature describes also channels of positive impact. For Greece the few studies that exist indicate negative effects. We try to contribute to these studies and shed more light not only on the sign of the uncertainty behavior but also on its heterogeneous character. To do this we employ a very large dataset that includes 25000 Greek firms' balance sheets covering all sectors and different firm sizes. Furthermore, we apply methods that take into account dynamic characteristics of firms performance, conditions of non-normality and different responses across quantiles. Such methods include panel dynamic models and panel quantile models.

At the beginning of our research we tackle the issue of finding an appropriate measure of economic uncertainty. The uncertainty proxy should correspond to the main political and economic events of the period of study and encompass information from domestic, EU and international sources. With this in mind we build a set of macroeconomic variables, survey-based indices and newspaper-based indices. We employ a dynamic factor model and we obtain the common unobserved factor as the measure of economic volatility. In contrast with one-dimensional proxies of uncertainty e.g. the Economic Policy Uncertainty of Baker et al.

(2016) or the Athens Stock Exchange volatility index, our approach is distinguished because it combines at the same time macroeconomic effects, political shocks, country-specific events and business sentiments.

The method mentioned above is presented in the first essay of our work. The volatility index data are inserted in a dynamic model that examines the investment under uncertainty for the Greek firm. The findings are confirmed by the theoretical and empirical literature of investment under uncertainty which is extensively presented in the essay. The impact of uncertainty is negative. The real options theory and the wait and see effects that are thoroughly analyzed in the seminal work of Dixit and Pindyck (1994) are to some extent also confirmed. The year of crisis intensify the negative role of uncertainty. A deeper analysis shows an heterogeneous behavior of the Greek firm that depends on it size and on the sector classification.

The heterogeneous nature of the uncertainty effect stimulates us to employ more sophisticated tools for studying the investment-uncertainty relationship. In the second paper we change the method of analysis to a panel quantile estimation framework. Panel quantiles estimators are more accurate and take into account the impact of the covariates on the entire conditional distribution of the response variable. The results of the original model are confirmed but our new approach give us a more comprehensive picture of the economic uncertainty behavior. Big investors and small investors in Greece respond in a different way. This different response across quantiles makes an important contribution to the empirical literature of investment under uncertainty but also recommends a strong policy implication for decision makers.

The last essay alters the field of our research to the profitability-uncertainty relationship. The empirical and theoretical literature on the profitability determinants is very rich. However, the uncertainty contributions has not been thoroughly discussed. Especially for Greece, efforts that have been made over time in the area of profitability determinants is rather poor. Thus, this paper is the first that examines the effects of uncertainty on the Greek firms profitability. To our knowledge, it is also the first that applies a panel quantile model to study the uncertainty impact on firms both at the aggregate and at the sectoral level.

The thesis is organized as follows: Chapter 2 examines the investment – uncertainty relationship. Chapter 3 introduces the panel quantile framework and chapter 4 discusses the effects of uncertainty on profitability. Conclusions of the three essays are summarized in chapter 5.

Chapter 2

What is the Investment Loss due to Uncertainty?

Abstract

We investigate the effect of uncertainty on investment. We employ a unique dataset of 25000 Greek firms' balance sheets for 14 years covering the period before and after the eurozone crisis. A dynamic factor model is employed to proxy uncertainty. The investment performance of 14 sectors is examined within a dynamic investment model. Robust GMM estimates of the investment rate model reveal a high degree of heterogeneity among these sectors. Overall uncertainty affects negatively investment performance and this effect substantially increased in the years of crisis. Agriculture and Mining are the least affected and the most affected ones include Manufacturing, Real Estate and Hotels. Focusing on the response of investment to uncertainty, it emerges that (relative) smaller firms are affected more compared to larger ones.

JEL classification: C23; D22; D81; D92; G31

Keywords: Greek firms, Uncertainty, Volatility, GMM, Panel data

*“Although our intellect always longs for clarity and certainty,
our nature often finds uncertainty fascinating”*

Carl von Clausewitz

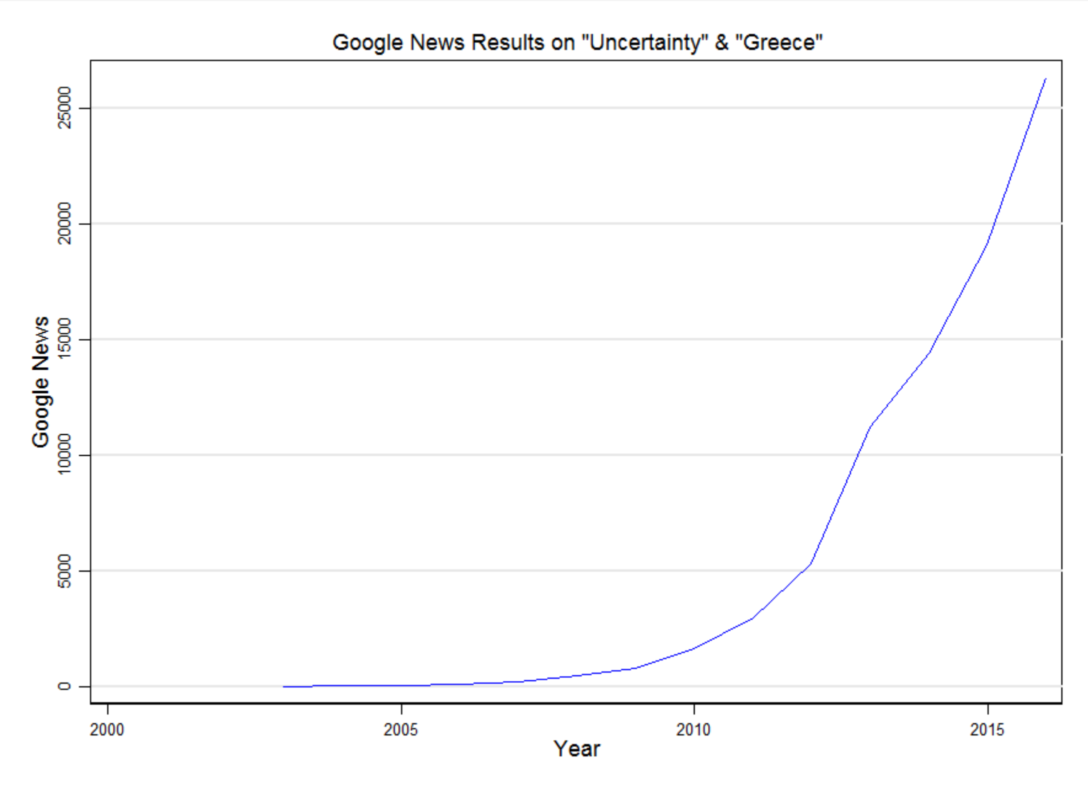
2.1 Introduction

Uncertainty is hard to measure and more than one ways of defining it exists. It is an abstract notion that affects both macroeconomic and microeconomic phenomena. The global financial crisis and the subsequent effects on economic activity have amplified the role of uncertainty in the economy overall (firms, households, sectors and policy makers). Most studies would capture uncertainty by a measure of volatility or with an index similar to the one proposed by Baker et al. (2016). Blanchard (2009) emphasizes the importance of uncertainty: *“Crises feed uncertainty. And uncertainty affects behavior, which feeds the crisis. Were a magic wand to remove uncertainty, the next few quarters would still be tough (some of the damage cannot be undone), but the crisis would largely go away”*.

There are alternative theoretical channels through which uncertainty affects economic activity and business decisions. Few imply a positive effect; an increase in uncertainty stimulates investment. Most of them would argue that uncertainty reduces investment and productive capacity and increases the cost of borrowing. This effect is larger for more irreversible investments and on investment in housing and the export sector. The theoretical literature is rich and will be presented in the next section. The empirical one is still growing. Overall, there is a broad consensus among empirical researchers that the relationship between investment and uncertainty is negative and only in a few cases, this nexus is weak or not significant.

Of particular importance is the case of Greece. The Greek economy has been through a period of high growth and low uncertainty from the introduction of the single currency (2001) till 2008-9. After this, it has been through a steep recession. The intensity of the recession (Greek GDP fell from €242 billion in 2008 to €179 billion in 2014) makes it a natural choice for further examination of the effect of uncertainty on investment. This time window (before and after the crisis) offers a distinctive paradigm for assessing the effect of uncertainty on investment. A Google news search on the terms “Greece and uncertainty” returns a quite impressive result: from 2003 to the end of 2008 there were 836 newspaper articles containing both words ("Greece" and "Uncertainty"). Over the 2009-2015 period, this number rose to 55.000 articles (see Figure 2.1). This turbulent economic environment offers an opportunity to revisit the causal nexus between uncertainty and investment. We employ a unique dataset of 25000 firms for 14 years (including the period before and after the crisis). This would allow us to quantify the cost of uncertainty with regard to investment.

Figure 2.1: Google News Results on "Uncertainty" & "Greece"



The purpose of this paper is to empirically investigate the effect of uncertainty on investment decisions. A dynamic factor model is employed to estimate a proxy for volatility. We construct a large panel dataset of Greek firms and examine investment performance by employing a dynamic investment model. We corroborate the existence of a negative effect of uncertainty on investment. Furthermore, we provide evidence of a within-sector heterogeneity based on firm sizes which appear to be crucial for the response of investment to uncertainty changes. Some sectors (and smaller firms) are more sensitive to uncertainty than others (bigger ones).

This work contributes to the empirical literature in four ways. To the best of our knowledge, this is (i) the first attempt to construct an extensive panel of annual data on 25000 Greek firms' balance sheets (overall more than 422000 obs). (ii) It covers the period before and after the global financial crisis (2000 to 2014). (iii) It is the first to analyze the effects of uncertainty on each of the sectors of the Greek economy which has experienced a significant shift in volatility within the sample we cover. (iv) Last we reveal the within-sector heterogeneity in firm sizes and in particular the different responses of investment to uncertainty based on the size of the firm.

The paper is organized as follows: Section 2.2 reviews the theoretical and empirical literature on uncertainty and investment. Section 2.3 outlines the econometric specification of the study and Section 2.4 discusses the data and the measures of uncertainty. Results are presented in Section 2.5. The last one concludes and provides policy implications.

2.2 Literature review

2.2.1 Theoretical literature

The classical approaches discuss choice under uncertainty looking at two different aspects of uncertainty; the objective and the subjective[1]. Keynes (1936) was one of the first to acknowledge a positive link between uncertainty and growth through the precautionary motive. For Keynes, the precautionary motive together with the transaction and the speculative motives constitute the three mechanisms that drive liquidity preferences. Sandmo (1970) provided additional support on the positive effects of uncertainty on saving decisions[2]. Another stimulating mechanism of the uncertainty influence is known as the Oi-Hartman-Abel effects and it is based on the models of Oi (1961), Hartman (1972) and Abel (1983). The

[1] In the former, probability distributions (objectives) are used to give a quantitative expression to the possible outcome. In the latter, no objective measure exists and uncertainty is treated in a subjective manner. The N-M model (Von Neumann and Morgenstern, 1953) belongs to the first case. The Savage Style model (Savage, 1954) of endogenous probabilities belongs to the second. The origin of the subjective probability theory, belongs to Ramsey (1926) and it was further developed by de Finetti (1937) and Savage (1954). A third approach combines the two previous ones using objective lotteries and subjective probabilities (Anscombe and Aumann, 1963).

[2]This positive link between uncertainty and growth has been also advanced by Mirman (1971), Drèze and Modigliani (1972), Skinner (1987), Blanchard and Mankiw (1988) , Kimball (1990), Caballero (1991), Skinner (1987), Deaton (1991), Carroll (1992), (1996), (1997), (2008); Carroll et al. (2003); Carroll and Samwick (1997), (1998)

underlying notion of this is that prices with greater variability get more probability weight, thus if the profits are convex more uncertainty will lead to increased expected profits. A third positive channel of uncertainty influence is the growth options mechanism based on the view that an increase in uncertainty raises the expected future profit stimulating investment decisions. It finds evidence especially in the cases of petroleum leases, R&D investments and construction lag phenomena[3].

The literature highlights two negative channels of the uncertainty effect. The first examines the effects of uncertainty from a financial perspective and links the increasing uncertainty with an increased risk premium. In other words, the investor interprets the uncertain macroeconomic or firm-specific environment as an increased cost of finance or as an increased probability of bankruptcy which makes her postpone or even cancel investment[4]. Risk aversion and the ambiguity aversion function is a related issue[5]. The second negative channel stems from the real options theory (also known as the theory of irreversible investment or the theory of the option value of waiting). The real options framework traces its roots back to Black and Scholes (1973), Merton (1973) and Cox and Ross (1976). Bernanke (1983) was one of the pioneers of the irreversible investment models and based his analysis on two main assumptions. The first is that an investment project takes place in conditions of irreversibility; this means that any alterations are highly costly. The second is that the arrival of new information over time provides the agent the opportunity, (i.e. the *option*) to postpone the project, to assess the business environment under the new conditions and to choose the right timing to maximize his returns. Dixit and Pindyck (1994) presented a thorough survey of the proposed theoretical approach and review the basic real options models of investment

[3] See Paddock et al, (1988), Bar-Ilan and Strange (1996), Kulatilaka and Perotti (1998), Minton and Schrand (1999), Folta and O' Brien (2004), Stein and Stone (2012), Segal et al. (2015), Kraft et al. (2013), Vo (2017), Czarnitzki and Toole (2006), (2008), (2013)

[4] See Pástor and Veronesi (2013), Arellano et al. (2011), (2018), Christiano et al. (2014), Gilchrist et al. (2014), Chen (2015).

[5] Earlier works on the mechanism of ambiguity and uncertainty aversion include Epstein and Wang (1994); Epstein and Zin (1991); Gilboa and Schmeidler (1989); Hansen et al. (1999). Recent works include Al-Najjar and Weinstein (2009), Miao et al. (2012), Ilut and Schneider (2012)

under uncertainty. Schwartz and Trigeorgis (2001) summarize the literature on the theoretical real options models[6].

2.2.2 Empirical literature

A vast empirical literature on the uncertainty-investment relationship grew out of the work of Jorgenson (1971) and that of Dixit and Pindyck (1994). The prior empirical literature, until the early 2000s, is reviewed in Carruth et al. (2000), Lensink et al. (2001) and Butzen and Fuss (2003) (for a more recent see Forbes (2016)). There is a broad consensus among empirical researchers that the relationship between investment and uncertainty is negative and there are only a few examples where this relationship is weak or insignificant. For example, from the twenty empirical papers presented in the literature table in Lensink et al. (2001), the seventeen indicate a negative sign of the investment-uncertainty relationship while only two indicate mixed evidence. Carruth et al. (2000) set two levels for the empirical analysis of the uncertainty – investment relationship: an aggregate that omits the idiosyncratic effects of the individual firm and a disaggregate that takes into account the idiosyncratic factors by using firm-level data. Our analysis belongs to the second group.

According to Bernanke (1983) an empirical analysis at the aggregate level (all industries) may have to address the following problems:

i. the incongruity of firms' uncertainty levels will have counteracting effects at the aggregate level (fluctuations may wash out)
ii. the economic uncertainty and the several macroeconomic factors are affecting the micro-level decisions
iii. the rate of diversification of an economy doesn't ensure immunity from shocks or decisions of *big players* (large firms, decision makers etc.).

Huizinga (1993) sheds more light to the problems mentioned above. When the US manufacturing sector is examined as a whole, an increase in uncertainty about real wages and real output prices leads to lower investment. When a cross-sectional analysis of manufacturing industries is performed, the response of the output prices is in the opposite

[6] See also Baldwin and Clark (1993); Baldwin and Trigeorgis (1993); Dixit (1992); Kulatilaka and Trigeorgis (1994); Pindyck (1991); Trigeorgis (1995).

direction. Carruth et al. (2000) argue that a firm-level approach offers the following advantages over an aggregate-level one:

i. it captures the idiosyncratic uncertainty of the individual firm
ii. it allows the use of panel data to examine the simultaneous effects between uncertainty and investment
iii. the panel data, when used, give the option to control for heterogeneity at the firm level

Econometric developments boosted further the interest on the effects of uncertainty on investment. One of the challenges that many studies face is the proxy measure of uncertainty. Two dimensions need to be discussed further here: the econometric and the economic one. The first is related to the econometric methods employed to measure uncertainty (e.g. stochastic volatility, moving standard deviation, GARCH models etc.) while the second concerns choosing the source of uncertainty (e.g. inflation, stock market, etc.). The vast majority of the empirical studies indicate that uncertainty, regardless of the proxy measure used, is negatively associated with the rate of investment and to the business cycle. However, in the case of R&D investments, some studies provide mixed results. Table 2.17 in the Appendix reviews 50 studies. Two of them find positive effects of uncertainty on liquidity, one finds positive effects of market uncertainty on investment and four provide mixed results. The rest of the studies indicate a negative relationship.

2.2.3 Uncertainty in Greece

The empirical literature on the relationship between uncertainty and business decisions in Greece is limited. Since joining the single currency in 2001 Greece has experienced positive growth rates that lasted till 2009. The average growth this period was 3.51%. Since 2009, Greece has entered a period of prolonged recession with severe macroeconomic implications (unemployment rate rose from around 10% to more than 25%). This environment provides a unique opportunity for the investigation of the uncertainty - investment nexus. Table 2.18 in the Appendix summarizes the existing studies that focus on Greece.

2.3 Empirical Specification

2.3.1 *q*-model of investment

The adopted framework is based on Tobin's q theory of investment (Tobin, 1969). The latter introduced the ratio q of the market value of assets (or investment) to its replacement cost (or book value). The firm will decide to invest depending on future profitability. Values of q above 1 encourage investment while values below 1 have a deterrent effect. In this context, the q-ratio relates investment to the firm's market valuation and can be considered as an index of the firm's investment behavior. The basic relationship can be written as:

$$\left(\frac{I}{K}\right)_{it} = \alpha + \frac{1}{b}(q_{it} - 1) + \varepsilon_{it} = \alpha + \frac{1}{b}Q_{it} + \varepsilon_{it} \tag{1}$$

where I_{it} is the gross investment, K_{it} the fixed capital stock, q_{it} the marginal q defined as the ratio of the shadow value of an additional unit of capital to its replacement cost, $Q_{it} = (q_{it} - 1)$ and ε_{it} is the error term[7]. The error term includes fixed (c_i) and time period effects (ζ_t):

$$\varepsilon_{it} = c_i + \zeta_t + e_{it} \tag{2}$$

The investment equation stems from a firm's profit maximization problem in a state of perfect competition and convex adjustment costs and represents one of the most popular empirical models of investment[8]. Frequently this model produces insignificant coefficients and low explanatory power. Lensink et al. (2001) argue that this can be attributed to the use of average q as a proxy for marginal q. This suffers from the strict assumptions of perfect competition and homogeneous production function. Furthermore, since market value data are needed to estimate the average q ratio[9], small and private firms are excluded from the sample. Bond et

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[7] Derivation of the q-model of investment with standard neoclassical assumptions is given in Blundell et al. (1992), Bond et al. (2004) and Bond and Van Reenen (2007).

[8] See: Summers (1981), Hayashi (1982), Fazzari et al. (1988), Blundell et al. (1992), Ferderer (1993), Bond et al. (2004), Bond et al. (2005), Bo and Lensink (2005), Mohn and Misund (2009), Henriques and Sadorsky (2011).

[9] Hayashi (1982) proved that if the firms are price takers with constant returns to scale the unobserved marginal q is equal to average q.

al. (2004) provide more explanations for this failure: the financing constraints of the firm, the fixed costs, imperfect competition, non-rational managerial behavior or decreasing returns to scale. To overcome these shortcomings the empirical q-models of investment are usually augmented by the presence of additional explanatory variables including cash flow variables, leverage, firm size or volatility indices. These variables are used in order to fill the missing information gap and to take into account the information asymmetries due to financing constraints (Fazzari et al., 1988) or to macroeconomic environment conditions. Tobin's q measures based on stock market did not prove helpful. They were replaced by alternative measures of the firm's growth opportunities e.g. the growth of sales, profitability or earnings forecasts. This is usually the case when privately held companies data are available and q_t is not directly observable or computable. Furthermore, many argue that such measures are more appropriate since stock market based q indices may suffer from measurement errors or low informative power.[10]

Despite the drawbacks, the q models of investment have become increasingly popular in the literature. When the focus is on the uncertainty effects, the q models are the benchmark approach. Augmented q-models have been applied to different sectors including manufacturing, construction, commerce, housing etc. and have been also adapted to aggregate, cross-sectoral or within sector analyses [11] .

2.3.2 Empirical model

We will start with a framework similar to Baum et al. (2008). We examine the investment behavior of a panel of Greek firms by employing the following investment model:

$$\left(\frac{I}{K}\right)_{it} = \alpha_0 + \alpha_1 \left(\frac{I}{K}\right)_{it-1} + \alpha_2 \left(\frac{CF}{K}\right)_{it-1} + \alpha_3 \left(\frac{GS}{K}\right)_{it-1} + \alpha_4 id_{i,t-1} + \beta h_{t-1} + c_i + u_{it} \quad (3)$$

[10] See Bond and Van Reenen (2007), Bond et al. (2005) and Erickson and Whited (2000) for related literature.

[11] See for example: Bellgardt and Behr (2002); Bond and Cummins (2001); Kalyvitis (2006); Kubota et al. (2013); Lerbs (2014); Tori and Onaran (2016)

where I is the investment, K the capital stock, CF the cash flow, GS the growth of sales, $id_{i,t}$ the idiosyncratic uncertainty, h_t the economic uncertainty, c_i the firm fixed effects and u_{it} the error term. To be consistent with the literature the lagged investment and the control variables of cash flow and growth of sales are expressed in rates deflated by the capital stock K. The investment dynamics and the *lagged investment effect* are taken into account by introducing lagged investment rate $\left(\frac{I}{K}\right)_{it-1}$ as a regressor. In this way the past investment behavior is taken into account in accordance with the proposition that there is an association between current and one-period lagged investment spending. This variable expresses the temporal persistence in investment and according to Eberly et al. (2012) it is the best predictor of investment at the firm level (much better than q_t or CF in terms of statistical significance).

To control for the firms' investment opportunities and to consider the growth potential of a company *CF* and *GS* variables also enter the model. Following a large strand of the literature[12], the growth of sales ratio is used instead of Tobin's *q*. The cash flow ratio and uncertainty augment the standard investment model. We choose to use this less restrictive approach of the *q*-model of investment for three reasons. The first is that we prefer a full-range sample in terms of firm size to a sample that consists only of large stock-market firms. For the latter q measures are computable but for the former, this is not applicable since the availability of market value data is limited. A wider coverage of the Greek firms' investment behavior is possible in this case. We choose to include in our sample small, midsized and large companies. The second reason is that the empirical performance of the traditional *q*-models of investment is not encouraging. That could lead us to departures from the original approach that only q matters for the firm's decision to invest and to augment the model with alternative measures. Third, the cash flow and growth of sales variables can adequately summarize the expected future profitability of the Greek firms and they can satisfactorily substitute q providing more informational power to the specification.

[12] See among others: Asker et al. (2011); Badertscher et al. (2013); Bo (1999); Bond et al. (2005); Ghosal and Loungani (2000); Rashid (2011); Rashid and Saeed (2017); Whited and Wu (2006).

With regard to uncertainty, it enters the model in lagged values to reflect the manager's response to the information acquired from the previous period. Furthermore time fixed effects were not included in the model because the economic uncertainty index doesn't vary cross-sectionally. By doing so we focus on the explanatory power of the uncertainty measure which would be otherwise absorbed by the year dummies because of collinearity issues.

2.3.3 Estimation technique

The empirical model is a dynamic investment model and follows the general form:

$$y_{it} = \alpha w_{it} + \beta x_{it} + c_i + u_{it} \tag{4}$$

where x_{it} is a vector of strictly exogenous variables, w_{it} the vector of endogenous or predetermined variables, c_i the unobserved group level effects, u_{it} the observation error term and *α, β* the parameters to be estimated. The w_{it} vector contains the autoregressive terms (lags of y_{it}). The conditions are:

$$E(c_i) = E(u_{it}) = E(c_i u_{it}) = E(u_{it} u_{is}) = 0$$
$$E(x_{it} u_{is}) = 0 \; for \; all \; s, t \text{ (For strictly exogenous variables)}$$
$$E(x_{it} u_{is}) = 0 \; for \; all \; s \geq t \text{ (For predetermined variables)}$$

The model is estimated using the first-difference Arellano-Bond estimator developed by Arellano and Bond (1991)[13]. This approach behaves well for *"small T, large N"* panels and has been a standard approach for solving the inconsistency problem of the dynamic linear models.[14] In our specification, the rates of lagged investment, cash flow and growth of sales and the intrinsic uncertainty are treated as endogenous variables. The economic uncertainty is treated as strictly exogenous. To avoid instrument proliferation, we invoke the "collapse"

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[13] Implemented in STATA 14 using Roodman (2007), (2009).

[14] In an autoregressive panel data model the lagged dependent variable is correlated with the individual effects c_i. By first-differencing the equations the method eliminates the unobserved group level effects and potential sources of endogeneity. For the first differences of predetermined and endogenous regressors the lags of their own levels are used as instruments. The strictly exogenous variables are used in the instrument matrix also in first differences.

option in order to restrict the lag ranges in the generation of the instruments sets. This method is suggested by Roodman (2007), (2009) to deal with the problem of endogenous variables overfitting.

We estimate our model by applying the Windmeijer (2005) WC-robust two-step estimator. This estimator overcomes the issue of downward biased standard errors and takes into account the finite sample bias by proposing a finite sample correction mechanism[15].

2.4 Data and Uncertainty proxy

2.4.1 Measuring Uncertainty

We need a proxy measure of uncertainty that would capture the economic and political events in Greece. We employ a dynamic factor model for two reasons. First, to take into account the time series dimension of our data and combine it with the traditional principal components and factor analysis methods. Second, using a dynamic factor model will reveal the common unobserved factor which will be used as the measure of economic volatility. The dynamic factor model represents the vector y_t of k dependent variables as a linear function of n_f unobserved factors and x_t exogenous variables. The unobserved factors f_t follow an autoregressive process:

$$y_t = Af_t + Bx_t + u_t \tag{5}$$

$$f_t = Cw_t + D_1 f_{t-1} + D_2 f_{t-2} + \cdots + D_{t-p} f_{t-p} + \varepsilon_t \tag{6}$$

$$u_t = E_1 u_{t-1} + E_2 u_{t-2} + \cdots + E_{t-q} u_{t-q} + v_t \tag{7}$$

We simplify the model by omitting the exogenous parts x_t and w_t:

$$y_t = Af_t + u_t \tag{8}$$

$$f_t = D(L) f_{t-1} + \varepsilon_t \tag{9}$$

[15] Windmeijer (2005) estimator provides Windmeijer-corrected cluster–robust standard errors. Thus, standard errors are robust to heteroscedasticity and serial correlation and adjusted for clustering at the firm level.

The parameters of the model are estimated by maximum likelihood (ML) in a state-space form and using the Kalman filter.[16] An important step is the selection of the number of factors. Several information criteria have been proposed in the literature. They extend the standard AIC and BIC criteria to take into account the unobserved common components and the cross-section dimension of the dataset. Bai and Ng (2002) examine the static case of approximate factor models and provide an upper bound of the true number of factors. Bai and Ng (2007), Hallin and Liska (2007), Onatski (2009), Barigozzi et al. (2016) suggest alternative criteria to determine the number of dynamic factors in large factor models. The finite sample properties of most of the information criteria and their performance are compared in Guo-Fitoussi (2013). The results show that in the case of small samples the Hallin and Liska (2007) and Onatski (2009) criteria can more accurately estimate the correct number of factors. We compute all of them.

We incorporate more than one macroeconomic variables and financial indicators. The uncertainty that the Greek economy is facing can be decomposed at three groups: domestic, EU and international. Our set includes 9 indices covering the period 1994M01 to 2015M08. The Greek specific ones are: Athens Stock Exchange closing prices (ASE), Long-term Government Bond Yields (BONDS), Bank interest rates (INTR), Industry Production Index (IP), Loans to domestic private sector (LOANS), Unemployment rate (UNEMPL), Economic Sentiment Indicator (ESI) and the European specific ones are Euro Area Business Climate Indicator (BCI) and Economic Policy Uncertainty (EPU). BCI and ESI indicators are survey-based measures for the Euro area and for Greece respectively. EPU is a policy uncertainty index based on the frequency of newspaper articles and references on the uncertainty created by Baker et al. (2016). Descriptions, transformations and sources of data are presented in Table 2.1.

[16] For more about dynamic factor and state space models see: Geweke (1977); Jong (1988), (1991); Lütkepohl (2005); Stock and Watson (1989), (1991).

Table 2.1: Macroeconomic Variables and Indices

	Variable	Abbreviation	Source	Transformation
Greek specific variables	Athens Stock Exchange closing prices	ASE	Athens Stock Exchange	(1− L)ln(Xt)
	Long-term Government Bond Yields	BONDS	Bank of Greece	(1− L)ln(Xt)
	Economic Sentiment Indicator	ESI	European Commission	(1− L)ln(Xt)
	Unemployment Rate	UNEMPL	Eurostat	(1− L)Xt
	Bank Interest Rate (Bank interest rates on new euro-denominated deposits and loans)	INTR	Bank of Greece	(1− L)ln(Xt)
	Industry Production Index (Total industry excluding construction)	IP	OECD	(1− L)ln(Xt)
	Loans to domestic private sector (Growth rate same period previous year)	LOANS	Bank of Greece	(1− L)Xt
Europe specific variables	Euro Area Business Climate Indicator	BCI	European Commission	Xt
	Economic Policy Uncertainty	EPU	Baker et al. (2016)*	Xt

Notes: *Xt* is the transformed variable and *L* is the lag-operator
*Data available on http://www.policyuncertainty.com/
The Economic Sentiment Indicator (ESI) and the Business Climate Indicator (BCI) are survey-based indices conducted by the Directorate General for Economic and Financial Affairs (DG ECFIN). In Greece, the surveys are conducted by the Foundation of Economic & Industrial Research (FEIR/IOBE).

We start our analysis by testing each of the variables for unit roots. The Phillips and Perron (1988) test is applied to the levels and first differences of the series. The results presented in Table 2.2 provide evidence against the null hypothesis. As a result, we can treat the first differences as stationary processes.

Table 2.2: Unit Root Tests

Series	Phillips–Perron Unit Root Test	
	Level	First Difference
ASE	-1.073	-14.500***
BCI	-3.785***	-12.344***
BONDS	-1.975	-13.399***
ESI	-1.373	-13.792***
EPU	-4.766***	-29.634***
INTR	-3.408**	-14.176***
IP	-1.149	-29.027***
LOANS	-0.857	-17.877***
UNEMPL	0.203	-12.735***

Notes: Phillips-Perron test (Ho: unit root), *** (**, *) rejects the null hypothesis at the 1% (5% and 10%) level, Phillips-Perron test includes an intercept term.

The next step would be to estimate the dynamic factor model. To construct the vector y_t of the dynamic factor model, we derive the individual measures of uncertainty from each of the transformed variables. The rolling standard deviation method is used to proxy volatility. We compute the individual volatility measures in a rolling window of 2 years with the exception of the EPU index (no transformation in this case as this is an uncertainty measure). The ASE volatility index is the conditional variance from a GARCH (1,1) model that accounts for the *volatility clustering* of the stock exchange market. All the series are demeaned and standardized by their standard deviation to have mean zero and variance one. We apply alternative information criteria for the selection of the number of dynamic factors. The results are presented in Table 2.3 and suggest the use of one dynamic factor.[17] Both the Akaike's and Schwarz's Bayesian information criteria suggest an optimal lag length of 1 for the unobserved factor autoregressive equation. The dynamic factor model estimates appear in Table 2.4. The unobserved factor will serve as a proxy for the uncertainty and is illustrated in Figure *2.2* annotated with the key events of recent years.

[17] Tests are based on a maximum number of factors *r=3*. All estimation were performed using Matlab (R2016a). The codes are publicly accessible at the author's webpage.

Table 2.3: Determining the Number of Factors

Tests	Number of factors							
Bai and Ng (2002)	IC1	IC2	IC3	PC1	PC2	PC3	BIC3	AIC3
	0	0	0	1	1	1	2	0
Bai and Ng (2007)					1			
Hallin and Liska (2007)	Penalty		a		b		c	d
	Large Window		1		1		1	1
	Small Window		1		1		1	1
Onatski (2009)					1			
Alessi et al. (2010)					1			
Barigozzi et al. (2016)	Penalty		a		b		c	d
	Large Window		1		1		1	1
	Small Window		1		1		1	1

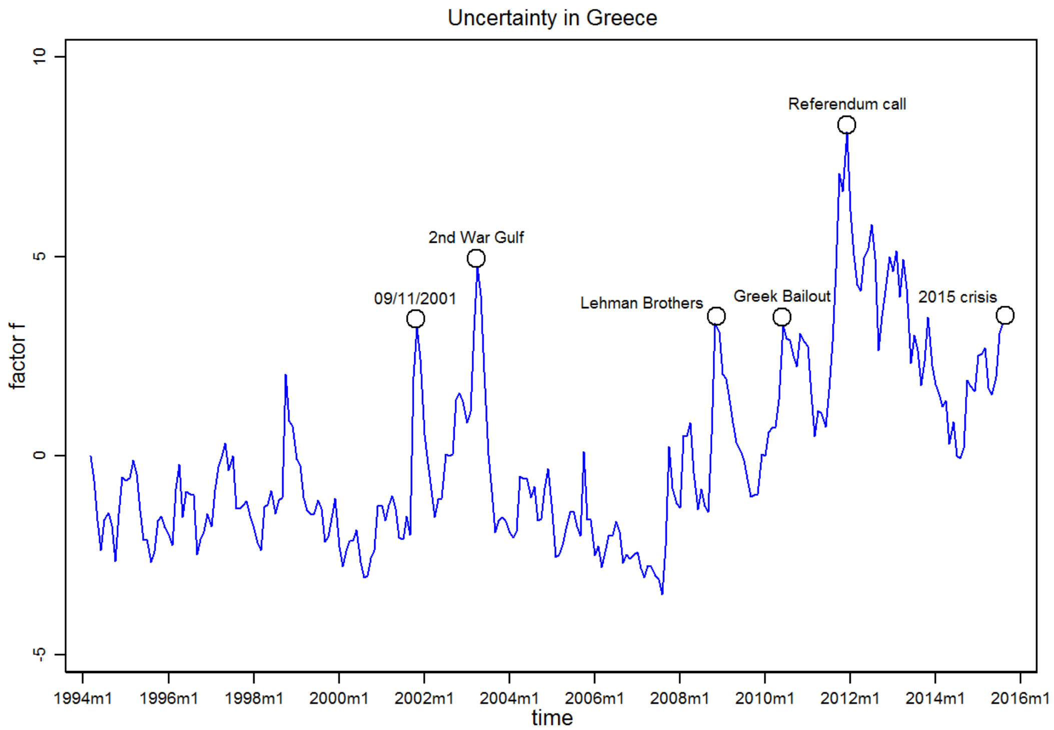
Notes: Sample size N=9, T=258. Tests are based on a maximum number of factors *r=3*. All estimation were performed using Matlab (R2016a). The codes are available at the author's web pages.

Table 2.4:Dynamic Factor Model Estimates

Variable	Coefficient	Std. Error	P>|z|
f t-1	0.922***	0.031	0.000***
ASE_{VI}	0.187***	0.037	0.000***
BCI	0.059**	0.028	0.033**
$BONDS_{VI}$	0.122***	0.041	0.003***
ESI_{VI}	0.076**	0.030	0.012**
EPU	0.354***	0.062	0.000***
$INTR_{VI}$	-0.058***	0.020	0.004***
IP_{VI}	0.114***	0.044	0.010***
$LOANS_{VI}$	-0.072***	0.019	0.000***
$UNEMPL_{VI}$	0.045	0.027	0.105
Wald *p*-value	0.000		

Notes: Subscript VI refers to volatility index; Robust std errors; * significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level

Figure 2.2: Uncertainty Proxy



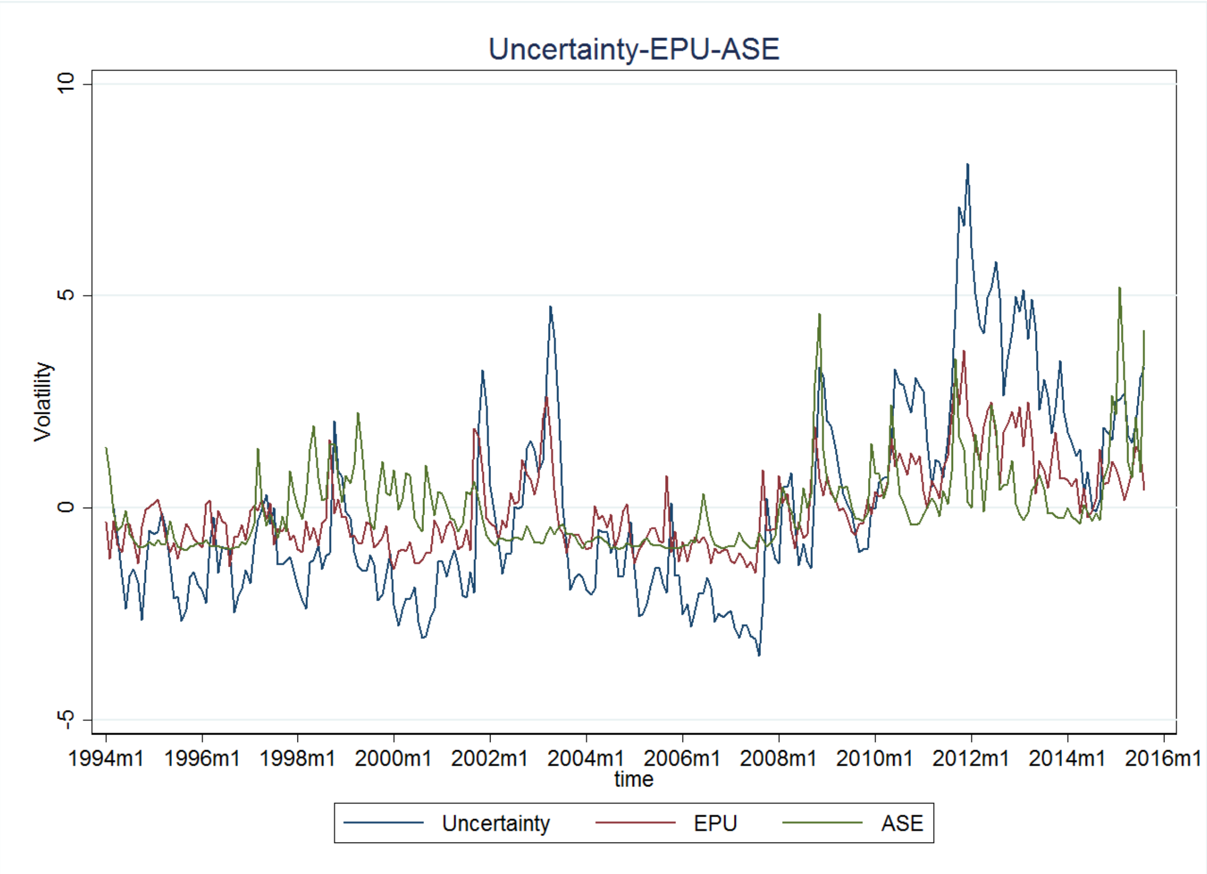
The derived uncertainty index can capture the most important macroeconomic events of the last decade and seems to follow closely the main political and economic episodes of the Greek financial crisis. Focusing on the coefficients of the unobservable factor one can argue that the strongest contribution to the construction of the factor stems from the EPU and the ASE indices. The correlation matrix between the uncertainty proxy and the individual uncertainty measures demonstrates a high correlation with EPU, ASE, LOANS, IP and BONDS volatilities (see Table 2.5). These variables are highly correlated with the computed uncertainty proxy. The patterns of EPU, ASE and the constructed index are compared in Figure *2.3*. In the robustness section, we will also confirm our results with alternative measures of uncertainty.

Table 2.5:Uncertainty Indices Correlation Matrix

Volatility	f	ASE_{VI}	BCI	$BONDS_{VI}$	ESI_{VI}	EPU	$INTR_{VI}$	IP_{VI}	$LOANS_{VI}$	$UNEMPL_{VI}$
f	1.0000									
ASE_{VI}	0.4571	1.0000								
BCI	0.1337	0.2794	1.0000							
$BONDS_{VI}$	0.3038	0.1361	-0.0200	1.0000						
ESI_{VI}	0.1686	0.1575	-0.0087	0.0060	1.0000					
EPU	0.8208	0.4258	0.1365	0.2621	0.2035	1.0000				
$INTR_{VI}$	-0.1302	0.0006	-0.0341	0.0127	-0.0688	-0.1358	1.0000			
IP_{VI}	0.2387	0.0847	-0.0118	0.0891	0.0080	0.2565	-0.0846	1.0000		
$LOANS_{VI}$	-0.1811	-0.0383	-0.0759	-0.0801	-0.0872	-0.1651	0.0257	-0.0838	1.0000	
$UNEMPL_{VI}$	0.0913	0.0990	0.0146	-0.0038	0.0669	0.0803	-0.0733	0.0598	-0.0394	1.0000

Note: Subscript VI refers to volatility index; f is the common unobserved factor estimated by the Factor Model

Figure 2.3: Economic Uncertainty-EPU-ASE



2.4.2 Firm-level Panel Data

Our sample consists of an unbalanced panel of 25000 Greek firms with sales turnover in excess of 100000€. We exclude smaller firms due to limited data availability and the degree of unbalanceness. The annual balance sheets span from 2000 to 2014 and were obtained from the Infobank Hellastat database (IBHS)[18]. The sample follows the national statistical

[18] See http://www.cbfa.gr/

classification of economic activities, called STAKOD–03 which is derived from the corresponding classifications of European Union (NACE Rev. 1.1) and United Nations (ISIC 3.1). Hence, we focus on the following sectors: 1) Agriculture, 2) Fishing, 3) Mining and Quarrying, 4) Manufacturing, 5) Electricity, Gas and Water supply, 6) Construction, 7) Wholesale and Retail Trade, 8) Hotels and Restaurants, 9) Transport, Storage and Communication, 10) Financial Intermediation, 11) Real Estate, 12) Education, 13) Health and Social Work, 14) Other Community, Social and Personal Service Activities.

Table 2.6: Sectors of Economic Activity in Greece

Sector	Section	Abbreviation
Agriculture, Animal Husbandry, Hunting and Forestry	A	Agriculture
Fishing	B	Fishing
Mining and Quarying	C	Mining
Manufacturing	D	Manufacturing
Electricity, Gas and Water supply	E	Electricity
Construction	F	Construction
Wholesale and Retail Trade; Repair of Motor Vehicles, Motorcycles and Personal and Household Goods	G	Trade
Hotels and Restaurants	H	Hotels
Transport, Storage and Communication	I	Transport
Financial Intermediation	J	Financial
Real Estate*	K*	Real Estate
Education	M	Education
Health and Social Work	N	Health
Other Community, Social and Personal Service Activities	O	Community

Notes: *The Real Estate sector of section K refers to division 70 without renting and business activities. The sectors of Public administration and defense; compulsory social security, Activities of households, and Extra-territorial organizations and bodies (Sections L, P, Q respectively) are not included due to limited availability of data. For more details on this see http://www.cbfa.gr/

To quantify the standard investment model of equation (3), we construct the following variables:

- Investment (I): Capital Expenditures in material fixed assets, equal to the change of the net value of fixed assets plus the year depreciation
- Capital Stock (K): The book value of total fixed assets
- Cash Flow (CF): Net profits plus depreciation
- Growth of Sales (GS): Change is sales S (annual turnover), $\Delta S_{it} = S_{it} - S_{it-1}$
- Idiosyncratic Uncertainty (id_{it}): Standard deviation of scaled sales estimated in a 5-year rolling window

- Uncertainty (h_t): The common unobserved factor as estimated by the dynamic factor model.

The descriptive statistics for these variables are presented in Table 2.7 covering three time periods: 2000-2008, 2009-2014 and 2000-2014. The investment rate shows that on average a Greek firm invests 16.8% of its total fixed assets in capital expenditures. This rate is different for the periods before (21.2%) and after (11.3%) the global financial crisis. The sizeable cash flow rate of 0.55 provides an indication of strong financial constraints (Fazzari et al., 1988). It is worth noting that the variables are skewed. As noted by Bo and Lensink (2005) this is a common feature of investment empirical models suggesting to keep the original data without transformation. The constructed variables are trimmed at the 5th and 95th percentile to reduce the potential effect of outliers. The economic uncertainty (h_t) observations are converted from monthly to annual frequency to match the panel data time unit reducing the informational content of the uncertainty factor.

Table 2.7: Descriptive Statistics

Time	Variable	mean	sd	p5	p25	p50	p75	p95
2000-2008	I/K	0.21239	0.25556	-0.06253	0.02539	0.13507	0.34576	0.75556
	CF/K	0.62032	1.08133	-0.09613	0.08379	0.23089	0.64103	3.03846
	GS/K	0.32903	2.56233	-3.14973	-0.11492	0.07663	0.69185	4.87830
	id_{it}	7.18990	14.81538	0.06100	0.31085	1.27772	6.12851	38.25301
	h_t	-1.04366	1.11913	-2.37267	-2.28133	-1.13620	0.02072	0.70187
2009-2014	I/K	0.11343	0.22211	-0.12434	0.00008	0.03422	0.16622	0.61721
	CF/K	0.45328	1.03013	-0.34396	0.01606	0.12635	0.43058	2.64983
	GS/K	-0.60644	2.70327	-6.01434	-0.79787	-0.08962	0.07901	2.60434
	id_{it}	6.91673	14.82692	0.05817	0.28747	1.11801	5.32149	37.88941
	h_t	2.42260	1.49445	0.25912	1.04542	2.58973	3.39777	4.65384
Total Sample	I/K	0.16772	0.24602	-0.09333	0.00669	0.08052	0.27394	0.70908
	CF/K	0.54804	1.06270	-0.21371	0.05094	0.18407	0.55359	2.88735
	GS/K	-0.10782	2.67019	-4.68852	-0.39371	0.00196	0.37024	3.96232
	id_{it}	7.02104	14.82456	0.05912	0.29597	1.17431	5.62592	38.05542
	h_t	0.34285	2.12800	-2.37267	-1.67847	0.19047	1.94258	4.65384

Notes: Investment (I): Capital Expenditures in material fixed assets
Capital Stock (K): The lagged book value of total assets
Cash Flow (CF): Net profits plus depreciation
Growth of Sales (GS): Change in annual turnover
Idiosyncratic Uncertainty (id_{it}): Standard deviation of scaled sales estimated in a 5-year rolling window
Economic Uncertainty (h_t): The common unobserved factor
sd is the standard deviation and p5-p95 are the percentiles of the variables. The variables are trimmed at the 5th and 95th percentile to reduce the effect of outliers

As a first step in the analysis of the sectors of the Greek economy, we provide their descriptive statistics in Table 2.19 in the online Appendix. Electricity, Transport, Trade, Health, Education are among the sectors with the strongest investment (higher average I/K). Hotels & Restaurants, Agriculture and Fishing appear to invest less (lower I/K). The growth of sales ratio takes negative values for the Hotels & Restaurant, Manufacturing, Real Estate, Construction Trade and Education sectors. We investigate this further by examining the samples for the two sub periods (before and after the crisis). There is a deterioration in the sales of the last years (2009-2014) which drives the total performance. Regarding the cash flow and idiosyncratic uncertainty indices the results are mixed.

2.5 Results

Regression analysis is carried out at 4 different levels: Aggregate level, firm level, sector level and within sector level. At the first level, we examine the effect of uncertainty using the entire dataset (where the sectoral heterogeneity is not taken into account). Next, we focus on the firm size by classifying our sample into three categories. At the sector level, we investigate the investment performance under uncertainty for each of the sectors of the economy. Finally, we consider a within sector analysis to assess the behavior of each sector depending on the size of the firm (analysis carried out on sector-specific samples). All these four levels of analysis would enable us to answer the question: what is the investment loss that can be attributed to uncertainty?

2.5.1 Aggregate level

We start with the results for the aggregate level that are reported in Table *2.8*. In the first model, we omit the volatility indices and estimate a standard investment model. The deflated cash flow and growth of sales regressors reveal a statistically significant and positive impact on the investment ratio. This first restricted version of the model statistically confirms the persistence characteristic of investment known as lagged investment effect. The same applies to the second model which includes the lagged value of idiosyncratic uncertainty. The contribution of the idiosyncratic ($id_{i,t-1}$) term to the investment performance is lower than other coefficients, however it is statistically significant at the 5% level. These restricted versions of the model (Model 1 & 2) pass the tests of second-order autocorrelation and the

Sargan–Hansen J-test of overidentifying restrictions suggesting the suitability of the instrument sets. The third version is the more complete one and it is augmented with the presence of the economic uncertainty measure. The control variables of lagged cash flow to total assets and lagged growth of sales to total assets carry the expected positive sign and are consistent with the theory and the empirical literature in terms of magnitude and sign. The lagged value of investment to capital stock takes a positive sign and confirms the lagged investment effect. However its, economic importance is doubtful, an indication that investments in Greece may focus on short-term horizons. All the coefficients of the third model are found to be statistically significant at the 1% level. The diagnostics indicate that there is no auto-correlation in residuals and that the instruments used are exogenous and valid. Both the economic uncertainty and the firm specific uncertainty factors carry the expected negative sign. If compared, we note that the effect of economic uncertainty appear to be greater than the effect of the firm specific uncertainty. At the aggregate level, this provides an indication that the investment performance of the Greek firms is affected in a non-homogenous manner by the alternative uncertainties. Economy-wide volatility impairs more the investment decisions compared to fluctuations in the micro environment of the firm.

Next, we investigate at the aggregate level the firms' investment behavior before and after the financial crisis. Table 2.9 presents the results for the periods 2000-2008 and 2009-2014. As expected, the negative impact of uncertainty on investment is substantially increased in the years of crisis from -0.006 to -0.033. In the same period, the investment lag effect is cut in half while the cash flows exhibit an unusual performance. In the period 2009-2014, the lagged cash flow coefficient takes a negative sign. This implies that when cash flows decrease (increase) the firms invest more (less). The investment – cash flow sensitivity has received much attention in the literature as an indication and measure of financial constraints. Fazzari et al. (1988), among others, support the view that higher cash flow sensitivities characterize financial constrained firms that find it hard to access external capital. Hovakimian (2009) argues that a negative sign reflects relative low internal liquidity and relatively high financial constraints. Bhagat et al. (2005) reveal that financially distressed firms with operating losses exhibit negative cash flow sensitivities but they continue to invest. In stressful operating conditions, the investments are funded by equity holders. In the period 2000-2008, the cash flow sensitivity is positive and strong. One apparently puzzling finding of the pre-crisis estimation results is the negative sign of the growth of sales coefficient. A deeper inspection of the descriptive statistics of the sample in the 2000-2008 period reveals that 36% of the growth of sales observations are negative. However, 49.5% of these firms present a positive change in investment rates. These results indicate that in the pre-crisis period the strong financial constraints and the decrease in the growth of sales were not important hindrances to investment. The same applies to uncertainty measures. To sum up, at (i) the aggregate level we demonstrate the negative effect of uncertainty on investment decisions. The next step would be to examine the effect of uncertainty on investment based on the (ii) the size of the firm, (iii) the sector and (iv) the size within the sector.

Table 2.8: GMM Estimates of Investment Rate - Entire Sample

Variable	Model1		Model2		Model3	
$(I/K)_{i.t-1}$	0.214**	(0.107)	0.082***	(0.014)	0.070***	(0.014)
$(CF/K)_{i.t-1}$	0.161***	(0.033)	0.297***	(0.058)	0.112***	(0.018)
$(GS/K)_{i.t-1}$	0.047***	(0.012)	0.038***	(0.014)	0.042***	(0.015)
h_{t-1}	-	-	-	-	-0.028***	(0.001)
$id_{i.t-1}$	-	-	-0.005**	(0.002)	-0.012***	(0.002)
Wald test (*p*-value)	0.000		0.000		0.000	
AR(2) test	1.93		0.79		0.087	
AR(2). *p*-value	0.053		0.428		0.931	
J (Sargan/Hansen) test	4.45		1.22		1.763	
J. *p*-value	0.616		0.747		0.623	
Number of Instruments	10		8		9	
Observations	422025		422025		422025	

Notes: The models are estimated using the first-difference Arellano-Bond estimator developed by Arellano and Bond (1991) and implemented in STATA 14 by Roodman (2009). Robust standard errors are reported in braces. Sargan–Hansen J-test is a test of overidentifying restrictions. AR (2) is the Arellano and Bond (1991) test for second order serial correlation. Robust standard errors are computed using the Windmeijer (2005) WC-robust two-step estimator. Instrument sets of the second through sixth lags of the right hand variables are used for the differenced equations. To avoid instrument proliferation we invoke the "collapse" option in order to restrict the lag ranges in the generation of the instruments sets. The *h* term is the measure of economic uncertainty. while the *id* term refers to the idiosyncratic uncertainty of each firm. To eliminate the effect of outliers the data are screened by trimming observations at the 5th and 95th percentile. The following tests are applied: 1. Sargan-Hansen J-test as a test of overidentifying restrictions. 2. The difference-in-Hansen tests of exogeneity and validity of instrument subsets (not reported but available on request). 3. The Arellano and Bond (1991) test for second order serial correlation and 4. The Wald chi-squared statistic of the null hypothesis that all the coefficients except the constant are zero.
* significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level

Table 2.9: GMM Estimates of Investment Rate - Before and after the Crisis

Variable	2000-2008		2009-2014		Total Sample	
$(I/K)_{i.t-1}$	0.069***	(0.011)	0.031***	(0.017)	0.070***	(0.014)
$(CF/K)_{i.t-1}$	0.191***	(0.047)	-0.113**	(0.045)	0.112***	(0.018)
$(GS/K)_{i.t-1}$	-0.022**	(0.009)	0.065***	(0.015)	0.042***	(0.015)
h_{t-1}	-0.006**	(0.003)	-0.033***	(0.001)	-0.028***	(0.001)
$id_{i.t-1}$	-0.0001	(0.002)	-0.005***	(0.002)	-0.012***	(0.002)
Wald test (p-value)	0.000		0.000		0.000	
AR(2) test	-0.33		-1.59		0.087	
AR(2). p-value	0.741		0.113		0.931	
J (Sargan/Hansen) test	8.97		3.24		1.763	
J. p-value	0.440		0.355		0.623	
Number of Instruments	15		9		9	
Observations	253215		168810		422025	

Notes: The models are estimated using the first-difference Arellano-Bond estimator developed by Arellano and Bond (1991) and implemented in STATA 14 by Roodman (2009). Robust standard errors are reported in braces. Sargan–Hansen J-test is a test of overidentifying restrictions. AR (2) is the Arellano and Bond (1991) test for second order serial correlation. Robust standard errors are computed using the Windmeijer (2005) WC-robust two-step estimator. Instrument sets of the second through sixth lags of the right hand variables are used for the differenced equations. To avoid instrument proliferation we invoke the "collapse" option in order to restrict the lag ranges in the generation of the instruments sets. The *h* term is the measure of economic uncertainty while the *id* term refers to the idiosyncratic uncertainty of each firm. To eliminate the effect of outliers the data are screened by trimming observations at the 5th and 95th percentile. The following tests are applied: 1. Sargan-Hansen J-test as a test of overidentifying restrictions. 2. The difference-in-Hansen tests of exogeneity and validity of instrument subsets (not reported but available on request). 3. The Arellano and Bond (1991) test for second order serial correlation and 4. The Wald chi-squared statistic of the null hypothesis that all the coefficients except the constant are zero.
* significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level

2.5.2 Firm size classification

The second level of analysis classifies firms based on their size (as determined by the firms' annual turnover). The first category includes firms below the 25th percentile (p25), the second between the 25th and the 75th and the third above the 75th percentile (p75). The GMM estimates are reported in Table *2.10*. Both the economic and idiosyncratic uncertainty have a negative impact on investment rate. However, firms behave differently in an uncertainty environment depending on their size. The effect of economic uncertainty on investment is stronger in the case of small-sized firms. Firms above p75 are affected less and seem more secure. The intrinsic volatility affects adversely the investment decisions but its role is more vital for the smaller firms. These results suggest that the investment of larger firms in Greece is more protected from uncertainty fluctuations compared to smaller firms while the smaller firms appear to be more vulnerable in volatility shocks compared to larger firms. The medium-sized firms are less affected by idiosyncratic shocks while their response to uncertainty is the same (-0.028) as in the aggregate level. Qualitatively similar are the results for the rest of the coefficients of the model. The lagged investment rate is approximately 4 times higher for the firms above p75 (0.028 to 0.122) showing that investment persistence is more profound for these firms. The lagged growth of sales is also differentiated across the sample and in terms of firm size. Thus, our results show that larger firms weigh more the expected future profitability when they decide to invest compared to small firms. The cash flow effect on investment is greater for the smaller firms and even stronger for the medium-sized ones. We interpret this result as an indication of the different degree of financial constraints and internal liquidity among the three categories of firms[19]. The large firms in Greece are positive - cash flow insensitive (compared to smaller firms), and seem to be less financially constrained. Small firms in Greece are the most influenced ones by economic and intrinsic uncertainty and are more responsive to cash flow and less to the growth of sales (when they decide to invest). The Wald test, the Arellano and Bond (1991) test for second-order serial correlation and the Sargan/Hansen test of overidentifying restrictions provide satisfactory results for all the models of our analysis.

Table 2.10: GMM Estimates of Investment Rate - Classified by Firm Size

Variable	Small firms ≤ p25		p25 < Medium firms < p75		Large Firms ≥ p75	
$(I/K)_{i.t-1}$	0.028	(0.024)	0.045***	(0.017)	0.122***	(0.030)
$(CF/K)_{i.t-1}$	0.064	(0.080)	0.099***	(0.032)	0.019	(0.077)
$(GS/K)_{i.t-1}$	0.007	(0.036)	0.048**	(0.024)	0.056*	(0.032)
h_{t-1}	-0.049***	(0.003)	-0.028***	(0.002)	-0.025***	(0.002)
$id_{i.t-1}$	-0.051**	(0.025)	-0.006**	(0.003)	-0.021***	(0.008)
Wald test (p-value)	0.000		0.000		0.000	
AR(2) test	-2.03		-1.45		1.59	
AR(2). p-value	0.042		0.146		0.111	
J (Sargan/Hansen) test	2.90		4.64		0.33	
J. p-value	0.716		0.914		0.848	
Number of Instruments	11		16		8	
Observations	63793		130137		66344	

Notes: The models are estimated using the first-difference Arellano-Bond estimator developed by Arellano and Bond (1991) and implemented in STATA 14 by Roodman (2009). Robust standard errors are reported in braces. Sargan–Hansen J-test is a test of overidentifying restrictions. AR (2) is the Arellano and Bond (1991) test for second order serial correlation. Robust standard errors are computed using the Windmeijer (2005) WC-robust two-step estimator. Instrument sets of the second through sixth lags of the right hand variables are used for the differenced equations. To avoid instrument proliferation we invoke the "collapse" option in order to restrict the lag ranges in the generation of the instruments sets. The *h* term is the measure of economic uncertainty while the *id* term refers to the idiosyncratic uncertainty of each firm. To eliminate the effect of outliers the data are screened by trimming observations at the 5th and 95th percentile The following tests are applied: 1. Sargan-Hansen J-test as a test of overidentifying restrictions. 2. The difference-in-Hansen tests of exogeneity and validity of instrument subsets (not reported but available on request). 3. The Arellano and Bond (1991) test for second order serial correlation and 4. The Wald chi-squared statistic of the null hypothesis that all the coefficients except the constant are zero.
* significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level

[19] See Allayannis and Mozumdar (2004); Bhagat et al. (2005); Drakos and Regent (2005); Fazzari et al. (1988); Gilchrist and Himmelberg (1995); Hassan et al. (2011); Hovakimian (2009); Marhfor et al. (2012); Schiantarelli (1996);

2.5.3 Sector level

We apply the empirical model of equation 3 on each of the sectors of economic activity in Greece. The results of the GMM regressions are presented in Summary Table 2.11 and in Table 2.20 in the Appendix. The degree of statistical significance varies across the model specifications. The coefficients of the uncertainty terms are the more stable in terms of statistical significance, however, their magnitude varies widely across sectors. The economic uncertainty affects negatively investment performance. The negative impact is found to be stronger on the Real estate sector, the Manufacturing sector and the Hotels & Restaurants sector (the latter is an indirect evidence of the sensitivity of the tourism sector to uncertainty). The effect is much smaller for the Agriculture, Mining and Electricity sectors. The impact of the lagged investment rate is small compared to the results reported in the literature (usually 0.3 to 0.5 for US or UK firms) and rather mixed, from 0.069 for the Health sector to 0.243 for the Mining sector. This indicates that the presence of the lagged investment effect is significant but not of the same magnitude for all the sectors. The same applies to the other coefficients of the model. What is worth mentioning: The relatively high coefficient values of the lagged cash flow rate for the Fishing (0.402) and the Real Estate (0.563) sectors and the strong effects of the growth of sales and idiosyncratic uncertainty for the Hotels sector (1.733 and -2.409 respectively). All in all, our analysis of the effects of uncertainty on investment show that there is a high degree of heterogeneity among Greek sectors.

We perform a disaggregated examination of the manufacturing sectors given the more detailed classification that is available (more than twenty two-digit SIC subsectors). Equation 3 is estimated for each of the manufacturing subsectors (Manufacturing of Tobacco products and Office machinery are excluded due to the lack of data). Table 2.23 presents the results of the GMM regressions. Coke & petroleum products and Motor Vehicles manufacturing are affected more, followed closely by Textiles industry and Pulp & Papers manufacturing. The Food & Beverages industry appears to be less sensitive to uncertainty effects. For the rest of the subsectors, the results of the disaggregated analysis are mixed.

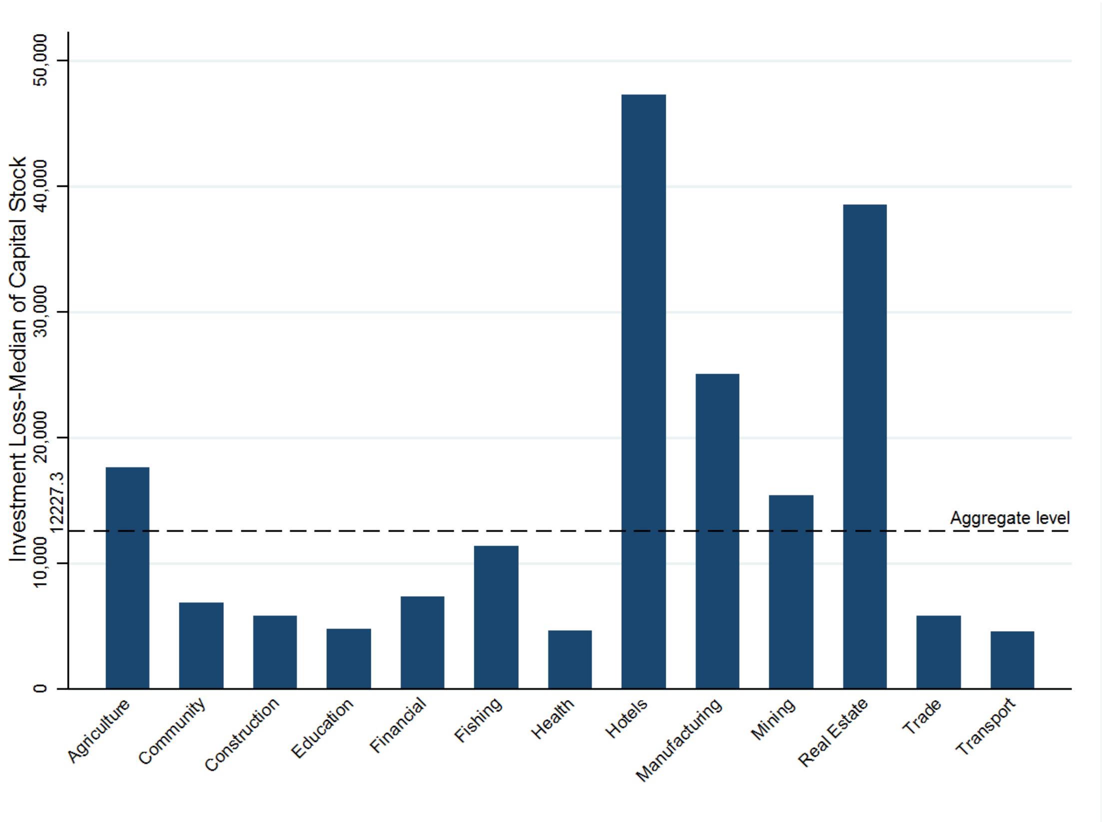
Table 2.11: GMM Estimates of Investment Rate - Sector Level - Summary Table

Time	Variable	Agriculture	Fishing	Mining	Manufacturing	Electricity	Trade	Construction
Sector level	I/K	0.146*	0.168**	0.243**	0.151***	0.135**	0.075***	0.133***
	CF/K	-0.030	0.402***	0.293*	0.184***	-0.263	0.067***	0.207**
	GS/K	0.137**	-0.047**	-0.100**	-0.028	-0.096	0.029***	-0.030**
	h_t	-0.018**	-0.025***	-0.018**	-0.032***	-0.018***	-0.025***	-0.019***
	id_{it}	-0.066**	0.095*	0.050	-0.063***	-0.009***	-0.005***	-0.002
Small Firms ≤ p25	I/K	0.149**	-0.062	0.384**	0.100**	-0.586**	-0.019	-0.285***
	CF/K	0.409	0.262	0.906***	-0.368**	-0.100	0.282*	-0.014
	GS/K	0.094	0.465***	0.201***	0.028	-0.090	-0.056**	0.005
	h_t	-0.040**	-0.011**	0.134***	-0.041***	-0.008**	-0.031***	-0.032**
	id_{it}	-0.475***	-0.426**	0.033***	-0.023**	-0.385	0.001	-0.002***
Large Firms ≥ p75	I/K	0.059	0.232	-0.253	0.125***	0.481***	0.132***	0.152***
	CF/K	-0.196**	-0.169	0.270**	-0.212	-0.007***	-0.015	0.029
	GS/K	0.031***	0.038	-0.013	0.214***	0.000	0.008**	0.009
	h_t	-0.016*	-0.059***	-0.031***	-0.028***	0.003***	-0.030***	-0.018***
	id_{it}	-0.010	0.385***	-0.017	-0.085***	0.006***	-0.003***	-0.016**
Time	**Variable**	**Hotels**	**Transport**	**Financial**	**Real Estate**	**Education**	**Health**	**Community**
Sector level	I/K	0.073**	0.107***	-0.067	0.077	0.086	0.069*	0.119***
	CF/K	-0.379	0.250***	0.016	0.563*	0.134***	0.113***	0.263**
	GS/K	1.733**	-0.013	0.007	0.088*	-0.046**	-0.014	-0.061**
	h_t	-0.048***	-0.019***	-0.024*	-0.046***	-0.022**	-0.022***	-0.021***
	id_{it}	1.733**	-0.013	0.007	0.088*	-0.046**	-0.014	-0.061**
Small Firms ≤ p25	I/K	-0.151	-0.078***	-0.307***	-0.144*	-0.307**	-0.213**	-0.137
	CF/K	-3.587	0.008	-0.002	0.761**	0.049***	0.053***	0.056**
	GS/K	6.748**	-0.004	0.000	-0.383**	0.046	0.018	-0.063*
	h_t	-0.060***	-0.020**	-0.038**	-0.017***	-0.039***	-0.072***	-0.046**
	id_{it}	-9.459***	-0.021***	-0.022***	0.117***	0.060**	0.012***	-0.076*
Large Firms ≥ p75	I/K	0.254***	0.137**	-0.094	0.267**	-0.263**	-0.058	0.142
	CF/K	0.400	0.059***	0.014	-0.170***	-0.298**	0.258***	0.180**
	GS/K	-2.262**	0.003	-0.016	-0.045***	0.046	-0.000	0.030
	h_t	-0.064***	-0.019***	-0.003	-0.089***	-0.019**	-0.030**	-0.041**
	id_{it}	-0.345	-0.001	0.005	-0.034	0.010	-0.025***	-0.087**

Notes: The table summarizes Tables 14, 15, 16 of online appendix. The models are estimated using the first-difference Arellano-Bond estimator developed by Arellano and Bond (1991) and implemented in STATA 14 by Roodman (2009). Robust standard errors are computed using the Windmeijer (2005) WC-robust two-step estimator. The *h* term is the measure of economic uncertainty while the *id* term refers to the idiosyncratic uncertainty of each firm. * significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level

We attempt to quantitatively assess the impact of uncertainty by calculating the investment loss for each of the economic sectors. The investment loss is the marginal effect of uncertainty on investment rate, ceteris paribus, multiplied by the median value of the capital stock. We excluded the electricity sector because of its extreme capital stock values. The results are presented in Figure *2.4*. Hotels, Manufacturing and Real Estate sectors suffer the greatest investment losses as the level of uncertainty rises. At the aggregate level, the median Greek firm suffers an investment loss of 12227€ when uncertainty is incremented by one unit. For hotels, this number is above 40000€ per firm per year and slightly less than that in the Real Estate sector.

Figure 2.4: Investment Loss

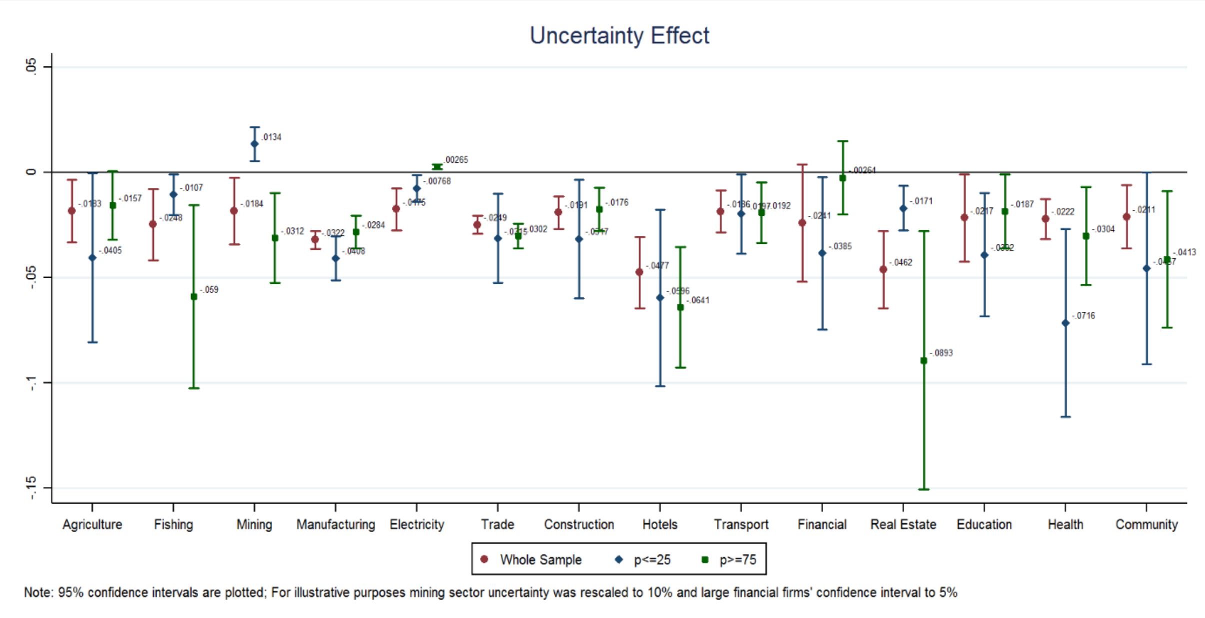


2.5.4 Within sector classification

To investigate the within-sector investment performance in conditions of uncertainty we conduct GMM regressions for the firms below the 25th percentile and the firms above the 75th percentile. The results are reported in Summary Table 2.11 and Table 2.21 & Table 2.22 in the Appendix. For illustrative purposes, Figure 2.5 summarizes in a bar chart the effect of uncertainty at the sector and within sector level. The investment decisions of the small firms are more severely influenced by macroeconomic volatility for most sectors of the analysis (Hotels, Fishing and Real Estate are the three exceptions). This effect is especially profound for the other Community, Social and Personal Service Activities sector (other services), the

Agriculture sector, the Education sector and the Health sector. In other words, small firms in these sectors are influenced much more by uncertainty compared to the large firms. For the rest of the sectors, the effect is the same but of a smaller magnitude. The same degree of heterogeneity is observed in the intrinsic component of the uncertainty effect. For several sectors, its contribution to investment performance is substantial and large. Particularly for the Hotels, the Agriculture and the Fishing sector, this effect is several times higher compared to the macroeconomic effect. For some sectors the id_{it} term takes positive values, something that is not in line with the previous results. We employed the rolling standard deviation of sales as a measure of the firm-specific uncertainty. Our findings reveal that for small firms of certain sectors the managerial response to volatility of sales is expansionary in terms of investment spending. A possible explanation could be that for these sectors (Mining, Real Estate, Education and Health) the increased variability in sales activates a growth option mechanism in order to gain a strategic advantage or to raise the expected future profits. Of course, further close investigation of the micro-environment of these sectors or a sectoral study which lies beyond the scope of this paper could help to realize the nature of this positive effect.

Figure 2.5: Uncertainty Effect on Investment - Sector Level



2.6 Robustness Analysis

2.6.1 The role of Debt

The role of debt ratio and its effect on the firm's investment policy has been studied extensively in the literature[20]. Results depend on the firm's growth opportunities, however, in many cases the link is negative. Baum et al. (2010) examined this link in an uncertain environment. They revealed a stimulating or mitigating effect of leverage depending on the uncertainty regime. We perform additional analysis to check the robustness of the empirical model and the stability of the results under different specifications. The alternative empirical model includes a lagged leverage effect $\left(\frac{D}{K}\right)_{i,t-1}$ as a regressor, where D is the total bank liabilities. The augmented model is presented in Table 2.12 and in Figure 2.6. The results are similar to the previous ones. The negative effect of uncertainty is confirmed again and the estimated coefficients take almost identical values. At aggregate level, the, impact of leverage on investment is found to be negative, thus the investment decisions of the Greek firms appear to be constrained by increased debt. To further evaluate the robustness of our findings, we conducted regressions at the sector level. The results are reported in Table 2.13 and a comparison graph of the uncertainty effect is presented in

Figure 2.7. For most sectors there is no qualitatively difference between uncertainty estimates. The models are not sensitive to the inclusion of the leverage effect and the significance of the coefficients is maintained in the alternative specification. The Agriculture, Financial, Real Estate and Community Sectors are the exceptions of the robustness analysis. For these sectors, the stability of the uncertainty effect is reduced by the introduction of the debt rate.

[20] See Ahn et al. (2006) for a brief literature review on leverage and investment.

Table 2.12: Robustness Analysis - The Role of Debt

Variable	Model1		Model2		Model3	
$(I/K)_{i.t-1}$	0.019	(0.028)	0.070***	(0.019)	0.076***	(0.012)
$(CF/K)_{i.t-1}$	0.186***	(0.046)	0.157****	(0.035)	0.093***	(0.027)
$(GS/K)_{i.t-1}$	0.127***	(0.023)	0.072***	(0.015)	0.035***	(0.012)
$(D/K)_{i,t-1}$	-0.116***	(0.038)	-0.094***	(0.030)	-0.055***	(0.019)
h_{t-1}	-	-	-	-	-0.029***	(0.002)
$id_{i.t-1}$	-	-	-0.003**	(0.001)	-0.005***	(0.002)
Wald test (*p*-value)	0.000		0.000		0.000	
AR(2) test	-1.05		0.32		-0.63	
AR(2). *p*-value	0.291		0.752		0.527	
J (Sargan/Hansen) test	1.38		7.20		2.60	
J. *p*-value	0.847		0.302		0.627	
Number of Instruments	9		12		11	
Observations	422025		422025		422025	

Notes: The models are estimated using the first-difference Arellano-Bond estimator developed by Arellano and Bond (1991) and implemented in STATA 14 by Roodman (2009). Robust standard errors are reported in braces. Sargan–Hansen J-test is a test of overidentifying restrictions. AR (2) is the Arellano and Bond (1991) test for second order serial correlation. Robust standard errors are computed using the Windmeijer (2005) WC-robust two-step estimator. Instrument sets of the second through sixth lags of the right hand variables are used for the differenced equations. To avoid instrument proliferation we invoke the "collapse" option in order to restrict the lag ranges in the generation of the instruments sets. The *h* term is the measure of economic uncertainty while the *id* term refers to the idiosyncratic uncertainty of each firm. To eliminate the effect of outliers the data are screened by trimming observations at the 5th and 95th percentile. The following tests are applied: 1. Sargan-Hansen J-test as a test of overidentifying restrictions. 2. The difference-in-Hansen tests of exogeneity and validity of instrument subsets (not reported but available on request). 3. The Arellano and Bond (1991) test for second order serial correlation and 4. The Wald chi-squared statistic of the null hypothesis that all the coefficients except the constant are zero.

* significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level

Table 2.13: Robustness Analysis - The Role of Debt - Sector Level

Variable	Agriculture	Fishing	Mining	Manufacturing	Electricity	Trade	Construction	Hotels	Transport	Financial	Real Estate	Education	Health	Community
$(I/K)_{i.t-1}$	0.243**	0.141**	0.238**	0.095***	0.056	0.088***	0.172***	0.303***	0.074**	-0.267**	0.104**	0.117*	0.105**	-0.039
	(0.121)	(0.065)	(0.094)	(0.019)	(0.095)	(0.020)	(0.044)	(0.068)	(0.036)	(0.117)	(0.048)	(0.067)	(0.051)	(0.050)
$(CF/K)_{i.t-1}$	0.490	0.146	-0.060	-0.099	-0.208**	0.075**	0.122**	0.652	0.137***	0.019	-0.131***	0.169***	0.155***	-0.192**
	(0.322)	(0.143)	(0.236)	(0.105)	(0.104)	(0.029)	(0.052)	(0.980)	(0.053)	(0.035)	(0.046)	(0.034)	(0.057)	(0.082)
$(GS/K)_{i.t-1}$	0.121*	-0.008	-0.042	0.044**	-0.052***	0.025**	-0.019*	-2.080*	0.005	-0.010	-0.027**	-0.017***	-0.019	0.042**
	(0.063)	(0.019)	(0.041)	(0.022)	(0.020)	(0.011)	(0.011)	(1.207)	(0.006)	(0.015)	(0.012)	(0.007)	(0.036)	(0.016)
h_{t-1}	-0.034***	-0.027***	-0.025**	-0.032***	-0.017**	-0.028***	-0.021***	-0.045***	-0.017***	-0.060**	-0.027***	-0.013	-0.026***	-0.046***
	(0.012)	(0.009)	(0.011)	(0.002)	(0.008)	(0.003)	(0.005)	(0.011)	(0.005)	(0.028)	(0.004)	(0.011)	(0.009)	(0.009)
$id_{i.t-1}$	-0.107**	0.074**	0.002	-0.020***	-0.003*	-0.004***	-0.002	-1.197*	0.001	0.047**	0.004	-0.001	-0.005*	-0.004
	(0.053)	(0.033)	(0.038)	(0.007)	(0.001)	(0.002)	(0.002)	(0.616)	(0.001)	(0.019)	(0.005)	(0.002)	(0.003)	(0.003)
$(D/K)_{it-1}$	0.272**	0.085***	0.143***	-0.105**	-0.562**	-0.033**	0.094***	2.595***	0.039**	0.064**	0.096***	-0.003	0.017	0.090***
	(0.130)	(0.020)	(0.039)	(0.043)	(0.224)	(0.015)	(0.033)	(0.878)	(0.019)	(0.026)	(0.032)	(0.045)	(0.047)	(0.033)
Wald test (*p*-value)	0.013	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.003	0.000	0.000	0.001	0.000
AR(2) test	-0.427	0.695	-1.211	-0.287	0.726	-0.847	0.977	-0.953	-1.418	0.264	0.118	-1.584	0.197	-0.271
AR(2) *p*-value	0.670	0.487	0.226	0.774	0.468	0.397	0.328	0.340	0.156	0.792	0.906	0.113	0.844	0.786
J (Sargan/Hansen) test	10.775	37.210	31.866	2.475	4.333	2.181	2.712	3.342	57.318	32.970	7.631	59.353	43.596	70.046
J. *p*-value	0.768	1.000	0.708	0.929	0.632	0.949	0.910	0.502	0.710	0.810	0.813	0.390	0.362	0.376
Number of Instruments	22	78	44	14	13	14	14	11	71	48	19	64	48	74
Observations	3105	1605	1965	86220	3375	144180	29505	46830	21855	6705	16425	4050	9075	9240

Notes: The models are estimated using the first-difference Arellano-Bond estimator developed by Arellano and Bond (1991) and implemented in STATA 14 by Roodman (2009). Robust standard errors are reported in braces. Sargan–Hansen J-test is a test of overidentifying restrictions. AR (2) is the Arellano and Bond (1991) test for second order serial correlation. Robust standard errors are computed using the Windmeijer (2005) WC-robust two-step estimator. Instrument sets of the second through sixth lags of the right hand variables are used for the differenced equations. To avoid instrument proliferation we invoke the "collapse" option in order to restrict the lag ranges in the generation of the instruments sets. The *h* term is the measure of economic uncertainty while the *id* term refers to the idiosyncratic uncertainty of each firm. To eliminate the effect of outliers the data are screened by trimming observations at the 1st and 99th percentile. The following tests are applied: 1. Sargan-Hansen J-test as a test of overidentifying restrictions. 2. The difference-in-Hansen tests of exogeneity and validity of instrument subsets (not reported but available on request). 3. The Arellano and Bond (1991) test for second order serial correlation and 4. The Wald chi-squared statistic of the null hypothesis that all the coefficients except the constant are zero. * significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level

Figure 2.6: Robustness Analysis - The Role of Debt

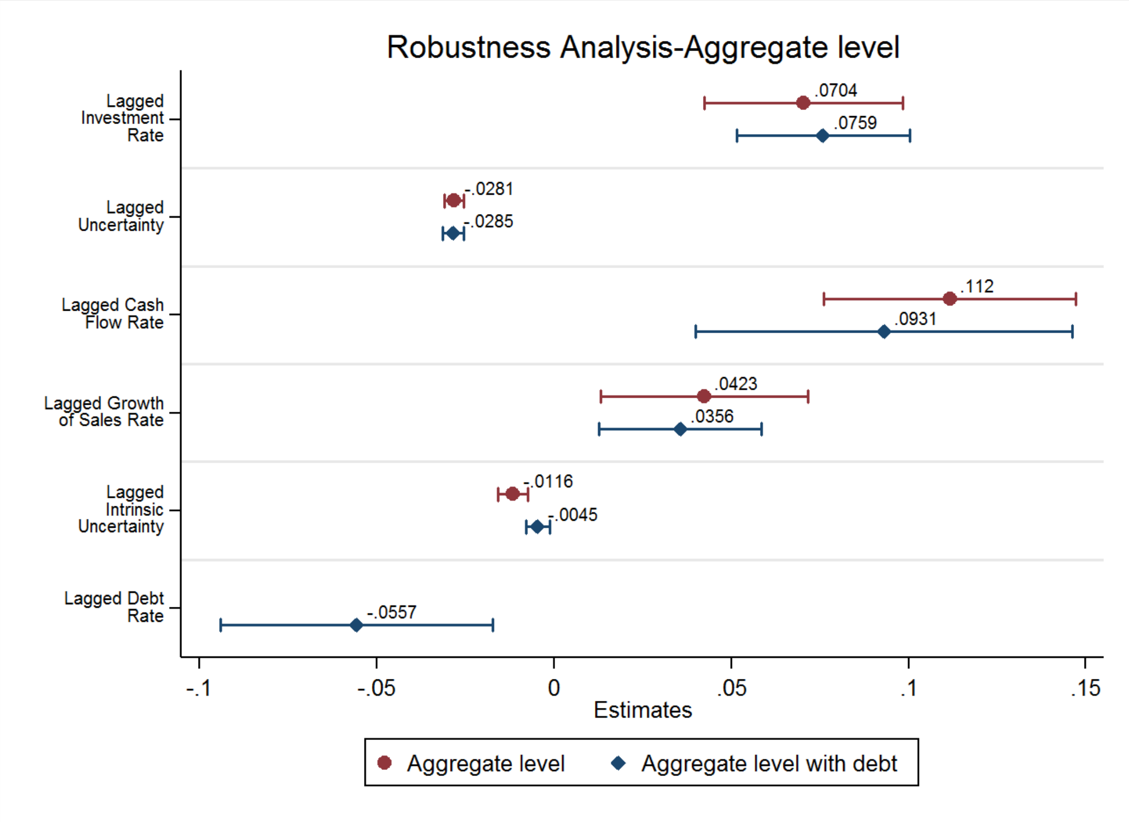
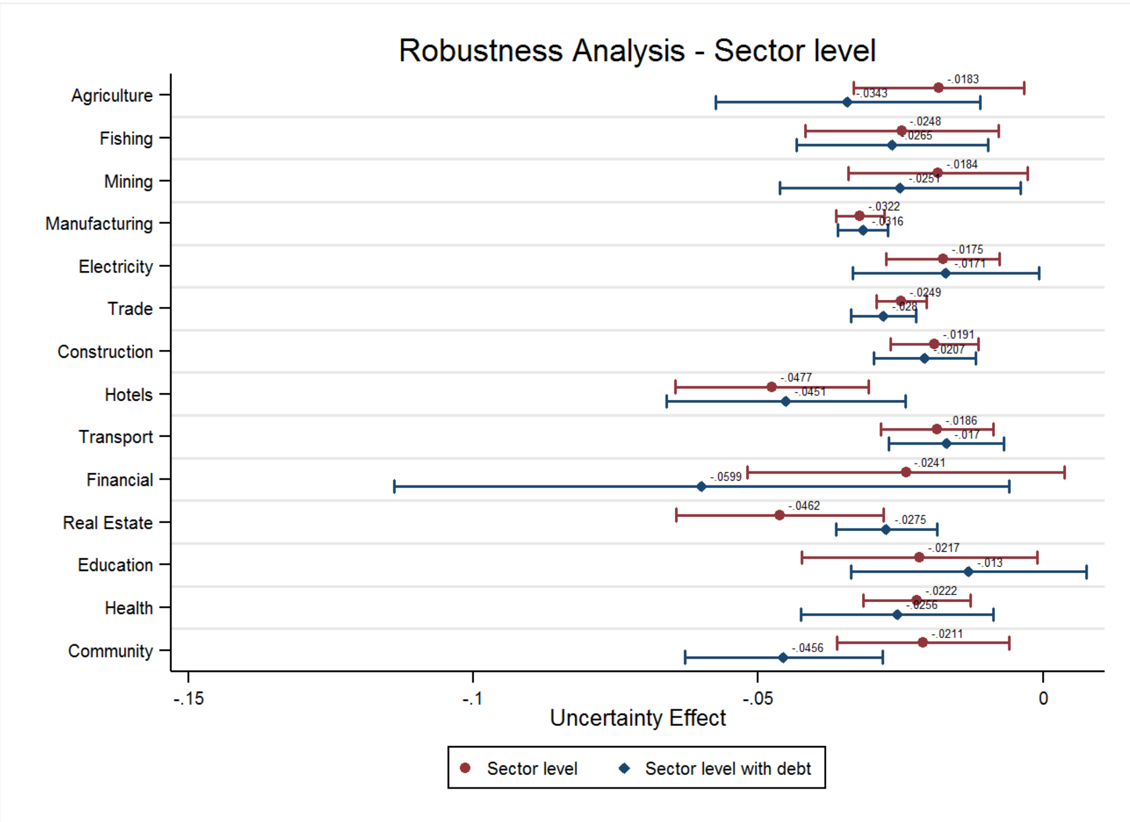


Figure 2.7: Robustness Analysis - Sector Level



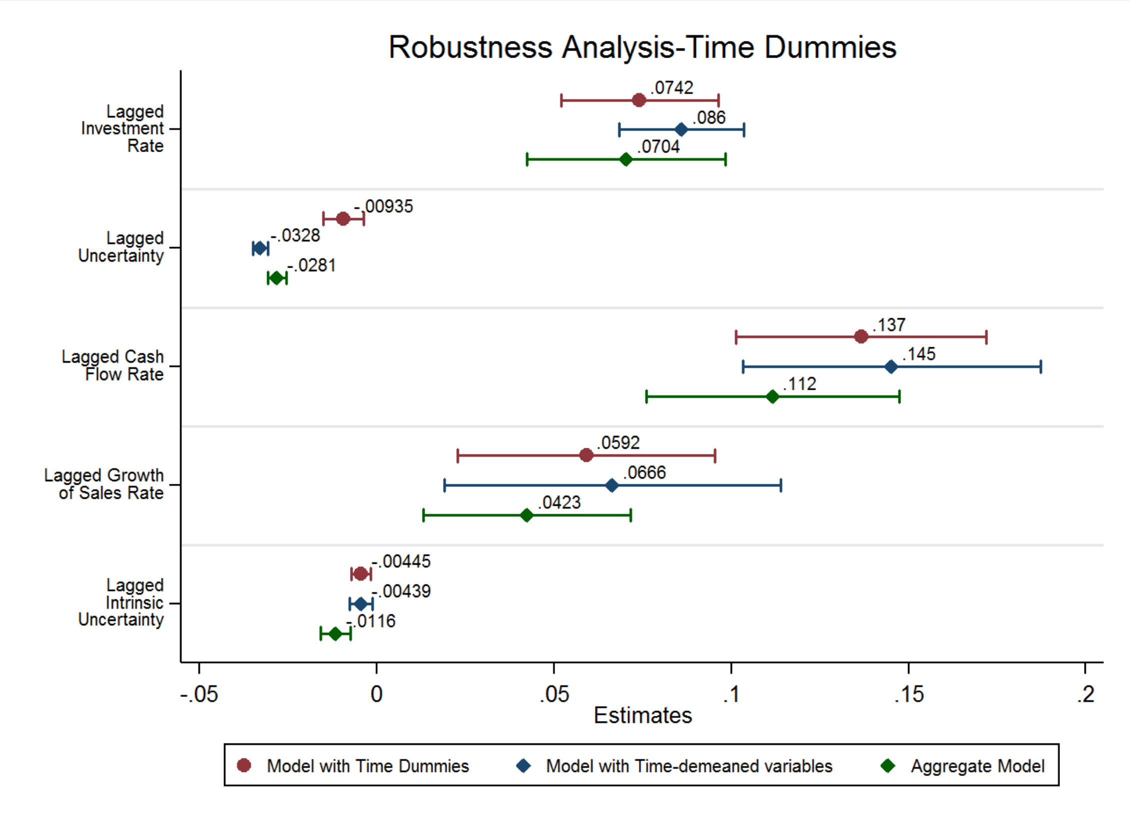
Another deviation from the model one would consider is a model with time dummies. Figure *2.8* presents the basic coefficients of the model together with their confidence intervals for (i) the model with time dummies, (ii) the model with time demeaned variables and (iii) the aggregate model we did consider in section 2.5.1. As one can observe the results with regard to the sign of uncertainty remain the same although in the case (i) the coefficient is closer to 0. Qualitatively deviations are not revealed in other cases. Table 2.14 also provides the starting fixed effects estimates of the aggregate model of section 2.5.1 which is in line with our previous results.

Table 2.14: Fixed Effects Coefficients of the Aggregate Model discussed in Section 5.1

VARIABLES	(1) Total Sample	(2) se	(3) Total Sample with Debt	(4) se
$(CF/K)_{i, t-1}$	0.062***	(0.002)	0.064***	(0.003)
$(GS/K)_{i, t-1}$	0.001*	(0.000)	0.001**	(0.001)
h_{t-1}	-0.019***	(0.000)	-0.022***	(0.000)
id_{t-1}	0.001***	(0.000)	0.001***	(0.000)
$(D/K)_{i,t-1}$			0.018***	(0.001)
Constant	0.115***	(0.001)	0.083***	(0.002)
R-squared	0.082		0.119	
R-square	0.082		0.119	

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Figure 2.8: Robustness Analysis - The Role of Time Dummies



2.6.2 Interaction terms

To further investigate the robustness of the results, we include an interaction term between uncertainty and growth of sales and another between uncertainty and cash flow ratio. The incorporation of these terms extends the basic model allowing to examine to what extent uncertainty affects investment through alternative channels. The results are presented in Table 2.15. Model 1 represents the basic model and models 2 and 3 are augmented with the interaction effects. The transmission mechanism of the volatility effect through the growth of the sales channel is negative and statistically significant. This shows that the impact of the growth of sales ratio on investment is weakening in case of higher uncertainty level. In other words, the investment response on the growth of sales is significantly lower when uncertainty increases. This finding indicates the existence of a "wait and see" effect in periods of high volatility. In these periods, Greek firms develop a precautionary behavior that leads to postponing or to canceling investments (they prefer the "option to wait"). This is in line with the theoretical literature of investment under uncertainty in a partial irreversibility framework and with the empirical findings of Bloom et al. (2007) and Bond and Cummins (2004). The alternative channel of cash flow interaction doesn't yield statistically significant results showing that in periods of high uncertainty the investment responsiveness is reduced through a demand shock channel rather than a profitability channel. However, the introduction of both interaction terms provide quite similar coefficient values and more support to the robustness of our model.

Table 2.15: Robustness Analysis - Interaction Terms

Variable	Model 1		Model 2		Model 3	
$(I/K)_{i.t-1}$	0.070***	(0.014)	0.071***	(0.009)	0.054***	(0.014)
$(CF/K)_{i.t-1}$	0.112***	(0.018)	0.168***	(0.023)	0.206***	(0.079)
$(GS/K)_{i.t-1}$	0.042***	(0.015)	0.029***	(0.009)	0.045***	(0.013)
h_{t-1}	-0.028***	(0.001)	-0.025***	(0.001)	-0.025***	(0.003)
$id_{i.t-1}$	-0.012***	(0.002)	-0.002**	(0.001)	-0.004***	(0.001)
$h_{t-1}\ x\ (GS/K)_{i.t-1}$	-	-	-0.018***	(0.003)	-0.018***	(0.005)
$id_{i.t-1}\ x\ (CF/K)_{i.t-1}$	-	-	-	-	0.006	(0.012)
Wald test (*p*-value)	0.000		0.000		0.000	
AR(2) test	0.087		-0.525		-0.977	
AR(2). *p*-value	0.931		0.600		0.329	
J (Sargan/Hansen) test	1.763		6.795		1.612	
J. *p*-value	0.623		0.658		0.807	
Number of Instruments	9		16		12	
Observations	422025		422025		422025	

Notes: The models are estimated using the first-difference Arellano-Bond estimator developed by Arellano and Bond (1991) and implemented in STATA 14 by Roodman (2009). Robust standard errors are reported in braces. Sargan–Hansen J-test is a test of overidentifying restrictions. AR (2) is the Arellano and Bond (1991) test for second order serial correlation. Robust standard errors are computed using the Windmeijer (2005) WC-robust two-step estimator. Instrument sets of the second through sixth lags of the right hand variables are used for the differenced equations. To avoid instrument proliferation we invoke the "collapse" option in order to restrict the lag ranges in the generation of the instruments sets. The *h* term is the measure of economic uncertainty while the *id* term refers to the idiosyncratic uncertainty of each firm. To eliminate the effect of outliers the data are screened by trimming observations at the 5st and 95th percentile. The following tests are applied: 1. Sargan-Hansen J-test as a test of overidentifying restrictions. 2. The difference-in-Hansen tests of exogeneity and validity of instrument subsets (not reported but available on request). 3. The Arellano and Bond (1991) test for second order serial correlation and 4. The Wald chi-squared statistic of the null hypothesis that all the coefficients except the constant are zero.
* significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level

2.6.3 Alternative uncertainty measures

The use of alternative measures of uncertainty is a third of the battery of robustness checks we performed. The macroeconomic variables and financial indicators of the dynamic factor model in Section 2.4.1 (with the exception of the unemployment index) are selected as individual proxies of volatility. We also introduce a new Greek specific measure of uncertainty $hgrexit_{t-1}$, an index based on the web search queries as provided by the Google Trends online tool[21]. The regression estimates are reported in Table 2.16. The results for the alternative specifications are very similar, in terms of magnitude and sign (the exception here is ESI and IP). Each alternative uncertainty index doesn't have the same impact on investment, a quite expected result. The $hgrexit_{t-1}$ index seems to underestimate the importance of the uncertainty effect compared to the initial model estimations. However, this is not necessary casting doubt on the selection of the common unobserved factor as an economic uncertainty index. Because of its simplicity the $hgrexit_{t-1}$ index may overlook certain aspects of the Greek case.

[21] The key phrases are: *Greek-Greece crisis, Greek debt crisis, Greece bailout, Greek debt, Grexit, Greece uncertainty*.

Table 2.16: Robustness Analysis - Alternative Uncertainty Measures

Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
$(I/K)_{i.t-1}$	0.070***	0.073***	0.049**	0.075***	0.082***	0.061***	0.047**	-0.024	0.077***	0.019
	(0.014)	(0.014)	(0.021)	(0.015)	(0.011)	(0.014)	(0.023)	(0.040)	(0.014)	(0.027)
$(CF/K)_{i.t-1}$	0.112***	0.147***	0.148***	0.128***	0.130***	0.138***	0.179***	0.155***	0.226***	0.156***
	(0.018)	(0.020)	(0.025)	(0.020)	(0.018)	(0.022)	(0.027)	(0.046)	(0.081)	(0.032)
$(GS/K)_{i.t-1}$	0.042***	0.059***	0.096***	0.051***	0.028***	0.069***	0.094***	0.183***	0.066***	0.127***
	(0.015)	(0.014)	(0.021)	(0.014)	(0.010)	(0.015)	(0.024)	(0.040)	(0.025)	(0.028)
$id_{i.t-1}$	-0.012***	-0.008***	-0.003*	-0.010***	-0.005**	-0.005***	-0.006*	-0.010**	-0.006**	-0.006**
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)	(0.004)	(0.002)	(0.003)
h_{t-1}	-0.028***									
	(0.001)									
$hgrexit_{t-1}$		-0.010***								
		(0.001)								
$hbci_{t-1}$			-0.012***							
			(0.000)							
$hepu_{t-1}$				-0.021***						
				(0.001)						
$hase_{t-1}$					-0.020***					
					(0.001)					
$hbonds_{t-1}$						-0.008***				
						(0.001)				
$hintr_{t-1}$							-0.023***			
							(0.001)			
$hloans_{t-1}$								-0.051***		
								(0.011)		
$hesi_{t-1}$									0.005***	
									(0.002)	
hip_{t-1}										-0.001
										(0.001)
Wald test (*p*-value)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
AR(2) test	0.087	0.824	-0.190	-0.195	-1.051	1.035	-0.159	-0.005	0.653	0.601
AR(2) *p*-value	0.931	0.410	0.850	0.845	0.293	0.301	0.873	0.996	0.514	0.548
J (Sargan/Hansen) test	1.763	4.561	7.820	1.783	0.492	3.698	2.596	0.361	0.306	0.376
J. *p*-value	0.623	0.335	0.098	0.619	0.921	0.448	0.273	0.548	0.858	0.540
Number of Instruments	9	10	10	9	9	10	8	7	8	7
Observations	422025	422025	422025	422025	422025	422025	422025	422025	422025	422025

Notes: The models are estimated using the first-difference Arellano-Bond estimator developed by Arellano and Bond (1991) and implemented in STATA 14 by Roodman (2009). Robust standard errors are reported in braces. Sargan–Hansen J-test is a test of overidentifying restrictions. AR (2) is the Arellano and Bond (1991) test for second order serial correlation. Robust standard errors are computed using the Windmeijer (2005) WC-robust two-step estimator. Instrument sets of the second through sixth lags of the right hand variables are used for the differenced equations. To avoid instrument proliferation we invoke the "collapse" option in order to restrict the lag ranges in the generation of the instruments sets. The *h* term is the measure of economic uncertainty while the *id* term refers to the idiosyncratic uncertainty of each firm. To eliminate the effect of outliers the data are screened by trimming observations at the 5th and 95th percentile. The following tests are applied: 1. Sargan-Hansen J-test as a test of overidentifying restrictions. 2. The difference-in-Hansen tests of exogeneity and validity of instrument subsets (not reported but available on request). 3. The Arellano and Bond (1991) test for second order serial correlation and 4. The Wald chi-squared statistic of the null hypothesis that all the coefficients except the constant are zero.
* significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level

2.7 Conclusions

This paper examines the link between uncertainty and investment decisions. Greece offers a useful paradigm as the country has experienced low and high levels of uncertainty within the time window that we employ. A unique dataset of 25000 firms for 14 years is constructed. We employed a dynamic investment model using GMM on aggregate, firm size classified, sector, within sector data. Our results reveal that uncertainty has a negative impact on economic activity and on the firm investment. This negative impact of uncertainty on investment is substantially increased in the years of crisis. However, its magnitude varies widely across sector samples indicating a high degree of heterogeneity among sectors. This negative impact is found to be stronger on the Manufacturing, Real Estate and Hotels sectors. Small firms behave differently compared to the large firms providing evidence of a within-sector heterogeneity in firm sizes. Large firms appear to have stronger protective mechanisms against uncertainty effects. The results are robust to the inclusion of the lagged leverage effect and to alternative interaction terms or uncertainty indices. The "wait and see" effect is present in periods of higher volatility which reduces the responsiveness of investment through a demand shock channel. Alternative approaches with regard to the model (debt), the variable that uncertainty affects more (interaction terms) or different definitions of uncertainty do not alter the results.

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2.9 Appendix

Table 2.17: Literature Review

	Title	Authors	Data	Methodology	Conclusions
1	Economic uncertainty and the effectiveness of monetary policy	Aastveit et al. (2013)	CPI, GDP, investment, consumption, interest rate indices for USA, Canada, UK and Norway covering the period 1971-2011 for USA and 1980-2011 for the other countries.	At first an investment decision theoretical model is used. Then a structural VAR model is constructed in which the uncertainty is treated as exogenous. Uncertainty is mainly proxied by the volatility index constructed by Bloom (2009). Other measures of uncertainty are also examined. Impulses responses of shocks in the monetary policy are estimated to examine the interaction effects.	Higher uncertainty makes the monetary policy less effective.
2	Investment under uncertainty	Antoshin (2006)	Accounts time series data for 77 oil companies from 1994 to 2004 (panel data) as well as stock prices, interest rates and oil prices data for the same period.	Through an extensive literature review, the author tries to capture the nonlinear behavior of uncertainty. Three measures of uncertainty are used. The stock price is used as a firm-specific uncertainty factor the oil price as an industry-wide factor and the interest rate as an economy-wide uncertainty factor. GARCH model are applied to calculate the historical volatility. OLS regressions and GMM estimators are employed to assess the effect of volatility on investment.	The three types of uncertainty are affecting negatively the investment with the interest rate appearing to be the most crucial one.
3	Macroeconomic uncertainty and private investment	Aizenman and Marion (1993)	Private investment, per capita income, human capital and various macroeconomic uncertainty measures for 40 developing countries over the 1970-1985 period.	Cross-section regressions with the share of private investment in GDP as the dependent variable. Uncertainty is measured by the standard deviation of the residuals of different macroeconomic variables via an autoregressive form.	In developing countries, there is a negative relationship between uncertainty and private investments.
4	Uncertain Times , uncertain measures	Alexopoulos and Cohen (2009)	IP, employment, labour productivity, consumption, investment over the period 1962-2008.	Two measures of uncertainty are used, the stock market volatility (Bloom et al., 2007) and a newspaper index based on New York Times' articles containing the words uncertain, uncertainty (combined with economy or economic). A series of VAR models are used to examine the response of variables to uncertainty shocks.	Any unanticipated rise in uncertainty level results in IP, employment, labor productivity, consumption and investment decrease, however the recovery period is short. The newspaper index shows a stronger explanatory power compared to the stock volatility index.
5	Uncertainty and Economic Activity: Evidence from Business Survey Data	Bachmann et al. (2010)	Business survey, industrial production, unemployment monthly data for USA and Germany.	Uncertainty is measured as the cross-sectional standard deviation of the Third FED District Business Outlook Survey (BOS) and the German IFO Business Climate Survey (IFO-BCS) responses. Then SVAR models are constructed and compared.	Positive shocks to business uncertainty affect negatively the economic activity. No evidence of a wait and see effect is found. They argue that “Bad times breed uncertainty” that is an epiphenomenon of bad times.
6	Measuring Economic Policy Uncertainty	Baker et al. (2013)	1. Text searched results for 10 US newspapers from 1985 onwards. 2. Schedules tax code expirations from the Congressional Budget Office. 3. Survey of Professional Forecasters (SPF).	The overall economic policy uncertainty index (EPU) is constructed as an weighted average of the three indices. Then a VAR model is employed to assess the EPU effects on investment, employment and the aggregate economic activity.	US and worldwide policy uncertainty increases since 2007 with negative effects on investment, GDP and employment.

	Title	Authors	Data	Methodology	Conclusions
7	The second moments matter: The impact of macroeconomic uncertainty on the allocation of loanable funds	Baum et al. (2009)	Total loans and total assets of US Banks 1979Q1-2003Q3. Industrial production and CPI conditional variance as proxies for macroeconomic uncertainty.	GARCH models proxying macroeconomic uncertainty. Relationship between standard deviation of the cross sectional dispersion of LTA ratios and macroeconomic uncertainty.	The role of macroeconomic uncertainty in the allocation of loanable funds is very important. A doubling of macroeconomic uncertainty leads to 6% - 10% change in the dispersion of banks LTA ratios.
8	Uncertainty determinants of corporate liquidity	Baum,Caglayan,Stephan,et al. (2008)	Panel data set of non-financial US firms covering the period 1993-2002.	1. Two period cash buffer stock theoretical model. 2. GARCH model - Conditional variance of CPI as proxy of macroeconomic uncertainty. 3. System GMM Estimator	The optimal level of liquidity and the macroeconomic uncertainty are positively associated. During recessions, the firms become sensitive to asymmetric information problems and they tend to increase their liquidity ratio as uncertainty increases.
9	The Impact of Macroeconomic Uncertainty on Non-Financial Firms ' Demand for Liquidity	Baum et al. (2005)	4125 US (4-digit SIC) non-financial firms panel over the period 1970-2000.	A reduced form relationship examines the linkage between macroeconomic uncertainty and the cross-sectional distribution of the cash-to-asset ratio. Four proxies for macroeconomic uncertainty are constructed from conditional variances of GDP, CPI, IP and S&P500 index estimated with a GARCH model.	Changes in macroeconomic uncertainty generate variations in the cross-sectional distribution of cash holdings. Higher uncertainty leads managers to adopt similar cash management policies while in a more stable macroeconomic environment they behave more idiosyncratically.
10	On the investment sensitivity of debt under uncertainty	Baum et al. (2010)	Total assets, capital stock for 7769 US manufacturing firms for the period 1987-2005 obtained from S&P database	A dynamic panel data is employed using two-step system GMM estimation. Various investment models are examined. Intra-annual variations are used to measure the uncertainty at the firm level and at the market level.	Both intrinsic (firm-specific) and extrinsic (market-level) uncertainty affect the influence of leverage on capital investment.
11	Uncertainty Determinants of Firm Investment	Baum,Caglayan and Talavera (2008)	S&P manufacturing firms (unbalanced panel) from 1984 to 2003. Data used include daily stock returns, market index returns, investment rate, Tobin's Q, cash flow/K ratio, Debt/K ratio.	Intrinsic and extrinsic uncertainty are computed from daily stock returns and market index returns respectively based on the methodology of Merton (1980). To examine the link between uncertainty and investment a dynamic panel data (DPD) is employed. Five models are examined: Without uncertainty, with own uncertainty, with market uncertainty, with the joint of the two uncertainties and with the introduction of their covariance (CAPM based uncertainty)	The own uncertainty and the CAPM based uncertainty affect the investment behaviour negatively while the market uncertainty positively.
12	Monetary Instability, the Predictability of Prices and the Allocation of Investment: An Empirical Investigation Using UK Panel Data	Beaudry et al. (2001)	Panel data set of UK companies over the period 1970-1990.	1. Theoretical model based on the Lucas island model. 2. Analyze the association between conditional variances obtained from the ARCH models for aggregate prices and money and the variance of the investment rate obtained from the panel. 3. Examine the relationship between the cross-sectional variances of profit rate and investment rate	There is a negative relationship between the conditional variance of inflation (uncertainty) and the variance of the investment rate and a negative correlation between the variance of the investment rate and the variance of the profit rate. A monetary instability, and its effect on the predictability of prices, may affect

	Title	Authors	Data	Methodology	Conclusions
					negatively the efficient allocation of investments.
13	Resolving Macroeconomic Uncertainty in Stock and Bond Markets	Beber and Brandt (2006)	Data of 161 auctions of economic derivatives from 10/2002 to 06/2005 and implied volatilities of stock and bond indices.	The authors are trying to examine the link between the ex-ante uncertainty as proxied by the economic derivatives and the ex-post uncertainty as measured by the changes in implied volatilities of bond and stock options.	Higher macroeconomic uncertainty is connected with drops in implied volatilities. Over 50% of this drop is captured by macroeconomic uncertainty.
14	Risk, uncertainty, and asset prices	Bekaert et al. (2009)	Bond market, inflation, equity market and consumption data from 1927 to 2004.	The effect of changes in uncertainty (proxied by the conditional variance of the fundamentals) and changes in the risk aversion on asset process is examined. A theoretical model is applied followed by an empirical implementation using a GMM estimation method.	The conditional volatility of cash flow growth as well as the risk aversion are two important factors of the variation in asset prices. The volatility of returns is affected more by the uncertainty factor while risk aversion appears to be more crucial for the risk premium and the dividend yields.
15	Global Macroeconomic Uncertainty	Berger et al. (2014)	Output growth proxied by industrial production and inflation data from 1965 to 2012 for 9 industrialized countries.	A bivariate GARCH-in-mean model is used to measure the effect of global uncertainty on output growth and inflation.	There is a significant effect of global uncertainty on output growth and inflation in most of the countries. Global real uncertainty has a negative influence on output growth.
16	Uncertainty and Investment Dynamics	Bloom et al. (2007)	Firm level unbalanced panel data of 672 UK manufacturing firms covering the period 1972-1991.	An investment decision model based on a Cobb-Douglas production function is developed. It is solved numerically and firm-level simulated investment and demand data are generated and analyzed. Next an ECM model using simulated data is employed. In the empirical section a ECM model is applied on a panel data of 672 UK firms. Uncertainty is measured by the standard deviation of daily stock returns.	The responsiveness of investment to demand shocks is reduced by higher levels of uncertainty. The response of investment to positive demand shocks is convex. In periods of higher uncertainty the response to any policy stimulus may be much lower than normal.
17	The impact of uncertainty shocks	Bloom (2009)	VXO index, S&P 500 index, FFR, earnings, CPI, interest, IPI, employment for the period 1962-2008	At first a VAR model is estimated and impulse response functions are plotted. Then a model of mixed labour and capital adjustment costs is built and it is solved using a moments' simulation method. Finally a large uncertainty shock is simulated.	Economic and political shocks increase the uncertainty substantially and have a great real-options influence on investment and hiring behaviour making the firms cautious. There are different contributions of first and second moment shocks to the hiring and investment behaviour of firms.
18	Uncertainty and investment: an empirical investigation using data on analysts' profits forecasts	Bond and Cummins (2004)	US firms data (stock market data, profits, cash flow) for the period 1982-1999	Various q models of investment are estimated (GMM) including three measures of uncertainty : "(1) the volatility in the firm's stock returns; (2) disagreement among securities analysts in their forecasts of the firm's future profits; and (3) the variance of forecast errors in analysts' forecasts of the firm's future profits"	Uncertainty strongly affects the firm's investment behaviour and a negative long-run effect exists.

	Title	Authors	Data	Methodology	Conclusions
19	Microeconometric evidence on uncertainty and investment	Bond et al. (2005)	655 UK firms panel for the period 1987-2000	A range of investment equations are estimated using four measures of uncertainty: 1) volatility of the firm's share price, 2) volatility of the average or 'consensus' forecasts of the firm's future earnings 3) dispersion across individual analysts in their forecasts of the firm's future earnings and 4) the variance of the forecast errors observed ex post for the consensus earnings forecasts.	There are negative effects of uncertainty on investment thus higher volatility leads to lower investment rates.
20	Political Uncertainty and Corporate Investment Cycles	Julio and Yook (2012)	Data from 248 national elections in 48 countries covering the period 1980-2005. Macroeconomic data including GDP, inflation, interest rate, government spending, M1 are used. Investment rate, cash flow and Tobin's Q are the firm-level data of the sample.	The effect of political uncertainty on firms' investment behaviour is examined. The initial hypothesis is that drops in investments become larger when the uncertainty about the election outcome is larger. Several regression models are applied to examine the rate of corporate investment around elections and across countries and time.	There is a 4.8% drop in the investment rate for the period before elections relative to non-election years. Countries with fewer checks and balances, unstable governments and politically sensitive corporations face stronger effects.
21	Macroeconomic Uncertainty and Macroeconomic Performance: Are they related?	Bredin and Fountas (2004)	G7 monthly data on IPI and CPI covering the period 1957-2003	A VARMA GARCH-M is adopted. Macroeconomic uncertainty is estimated by the conditional variance of the model.	Uncertainty of output growth affects positively the growth rate. Inflation uncertainty isn't detrimental for output growth.
22	Investment and Uncertainty in the G7	Byrne and Davis (2005)	Quarterly time series for G7 countries over 1968-2001 (business output, capital stock, investment). CPI, interest, exchange rate, IP and stock market index data for the G7 are used to generate uncertainty proxies	An accelerator based investment function using PGME for dynamic heterogeneous panel and MGE for individual country. GARCH model was used to measure the conditional volatility and uncertainty.	Exchange rate uncertainty affects negatively investment while inflation and industrial production uncertainty are not crucial for investments across the G7.Long-term interest rate uncertainty influences investments.
23	Uncertainty, Investment, and Industry Evolution	Caballero and Pindyck (1992)	Output and input data for US manufacturing industries for a 29 year period 1958-1986	An theoretical investment model is used. Sample standard deviations measure aggregate or idiosyncratic uncertainty.	Doubling of the aggregate uncertainty leads to a 20% increase of the required rate of return on new capital.
24	Political Instability, Uncertainty and Economics	Carmignani (2003)	Budget deficit, unemployment, output growth, debt, cabinet alterations, party system polarization,	The empirical analysis is generally based on a regression equation with an economic variable as a regressand and two sets of economic control variables and political variables as the regressors. The author employs a model of budget deficit with a cabinet instability variable as the key political instability factor (estimated by a probit model)	There is evidence that government instability increases the budget deficits.
25	Econometric Modelling of UK Aggregate Investment: The Role of Profits and Uncertainty	Carruth et al. (1997)	UK data over 1964-1995 for ICC investments, GDP, profits, sterling gold price, long-term interest rate.	An ECM model was used. As proxy for uncertainty the gold price is employed.	The dynamic model in the short-run suffers from heteroscedasticity. The ICC profits and the price of gold explain the investment spending by the ICC sector.
26	Profitability, capacity, and uncertainty: a model of UK manufacturing investment	Driver et al. (2005)	Investment, manufacturing output, earnings, depreciation, capacity utilization and GDP's forecast data for UK firms from 1977 to 1999.	A VECM model is used with investment as a dependent variable with evidence of one co-integrating vector. Uncertainty is measured based on the dispersion of GDP's forecasts across several forecasting organizations.	Uncertainty as measured by the dispersion of GDP's forecasts across several forecasting organizations depresses aggregate investment.

	Title	Authors	Data	Methodology	Conclusions
27	The Real Effects of Political Uncertainty: Elections and Investment Sensitivity to Stock Prices	Durnev (2010)	An unbalanced panel data set for 47808 firms from 79 countries for the period 1980-2006 and a sample of 466 elections for the same period. GDP, exchange rate and inflation are used for measuring the macroeconomic volatility.	Two types of regressions are performed one to assess the sensitivity of each country and another augmented by country controls as the real GDP growth and the financial development. The macroeconomic volatility is measured in a ten-year rolling window including the standard deviation of real GDP per capita, the standard deviation of the real exchange rate and the standard deviation of the inflation rate.	During election years there is less sensitivity of investment to stock prices, larger drops in investment-to-price sensitivity in case of more uncertain election outcome. This drop is connected with the lower company performance after the election period and is larger in countries with more corruption and larger state ownership.
28	The Spline-GARCH Model for Low-Frequency Volatility and Its Global Macroeconomic Causes	Engle and Rangel (2008)	S&P 500 data for the period 1955-2003, Market data for developed countries and emerging economies over the 1990-2003 period.	A Spline-Garch model is used where a smooth curve (trend) describes the low-frequency volatility which coincides with the unconditional volatility. Next a cross-sectional analysis is performed to search for the main macroeconomic determinants of this low-frequency volatility.	The low-frequency volatility is affected negatively by the size of the market (number of companies) and positively by the size of the economies (GDP)
29	The relationship between economic growth and real uncertainty in the G3	Fountas and Karanasos (2006)	IPI (as a proxy of output) for USA, Japan and Germany from 1850 to 1999.	They use the methodology of GARCH-ML proxying uncertainty by the conditional variance of output growth	For Germany and USA output growth has a negative effect on output growth uncertainty. For Germany and Japan output growth uncertainty is a positive determinant of output growth.
30	Inflation, output growth, and nominal and real uncertainty: Empirical evidence for the G7	Fountas and Karanasos (2007)	CPI and IPI data for US and G7 from 1957 to 2000.	They examine the relationship between output growth (inflation) and output (inflation) uncertainty performing Granger causality tests. They estimate uncertainty by the conditional variance of the variables following a GARCH approach.	1. Inflation is a primary determinant of its uncertainty. 2. Inflation uncertainty isn't detrimental for output growth. 3. There are different reactions by each country to a change of inflation uncertainty. 4. Uncertainty of output growth affects positively the growth rate. 5. Uncertainty of output doesn't lead to more inflation.
31	The Differential Impact of Uncertainty on Investment in Small and Large Businesses	Ghosal and Loungani (2000)	Annual (1958-91) SIC 4-digit industry time-series data	A panel data model of irreversible investment was tested. The profit uncertainty is measured by the standard deviation of the residuals (moving standard deviation)	There is a negative relationship between investment and uncertainty and the quantitative negative impact is greater in the industries dominated by small firms.
32	US presidential elections and implied volatility: The role of political uncertainty	Goodell and Vähämaa (2013)	Monthly data for VIX, inflation, consumer confidence index, unemployment, Moody's bonds, S&P500 index, IEM presidential contracts covering the period 1992-2008 (five presidential elections)	The methodology examines the relationship between US elections and the volatility of the stock markets by regressing the monthly percentage index of VIX on the monthly percentage change in the probability of success and several control variables.	Positive changes in the probability of success of the eventual winner increases the stock market volatility.

	Title	Authors	Data	Methodology	Conclusions
33	Expectations of Equity Risk Premia, Volatility and Asymmetry from a Corporate Finance Perspective	Graham and Harvey (2001)	Multiyear survey of Chief Financial Officers (CFOs) of U.S. corporations	Based on a multiyear survey which is designed to measure the expectations of risk premia capturing market volatility and asymmetric distributions	Low returns are associated with higher volatility and more negative asymmetry. Negative return shocks increase volatility.
34	The effect of oil price volatility on strategic investment	Henriques and Sadorsky (2011)	Unbalanced panel data of US firms covering the period 1990-2007 (investment, capital stock, assets, Tobin's Q, cash flow, oil price volatility)	Two OLS and five GMM model are employed. Oil price volatility is measured according to Sadorsky (2008)	The relationship between the firm level investment and the volatility of oil price follows a U shape.
35	Dimensions of macroeconomic uncertainty: A common factor analysis.	Henzel and Rengel (2013)	164 individual uncertainty measures (US) split up in 14 categories from 1970 to 2011.	A RiskMetrics procedure is followed to measure uncertainty because of its simplicity and robustness. Compared to SV measures of uncertainty, a high degree of correlation is found. Then a factor model and a rotation strategy are employed to find respectively the number and the identity of the common driving forces of the uncertainty measures. The two indicators are the business cycle uncertainty and oil and commodity price uncertainty.They are compared to the familiar and widely used uncertainty measures and through a VAR model their impact on the economic activity is examined.	1. A small number of factors account for the changes of macroeconomic uncertainty. 2. Business cycle uncertainty and oil and commodity price uncertainty appear to be the two fundamental factors of uncertainty. 3. Macroeconomic uncertainty has a non-negligible influence on economic activity.
36	Capital flight and the uncertainty of government policies	Hermes and Lensink (2001)	LDCs 1971-1991 data for deficits, taxes, government consumption, inflation, interest rate (uncertainty measures), bank lending, foreign aid, political instability, civil liberties	Several regressions are employed based on a different measure of uncertainty each time. Uncertainty is measured as the standard deviation of the residuals of an autoregressive process.	Policy uncertainty affects positively and statistically significantly the capital flight from LDCs.
37	Inflation Uncertainty, Relative Price Uncertainty, and Investment in U.S. Manufacturing	Huizinga (1993)	Quarterly data on inflation, wages, output price, profit for 1954-1989. Annual data on investment, capital stock, output, wages, materials' costs, and prices for the period 1958 to 1986 for 460 US manufacturing industries.	1. Time series evidence A univariate ARCH model was fit to quarterly data on each series. The conditional variance of the series is used as a measure of uncertainty in order to take into account the "fluctuations about a predicted future path" and not just fluctuations around an average value. (unconditional variance) 2.The relationship between inflation uncertainty and other types of uncertainty and investment are examined 3. The cross-sectional variation in uncertainty and investment is analysed.	Increased inflation uncertainty is connected to uncertainty about important economic variables. Temporary increase in real wages uncertainty and permanent increase in output price uncertainty predict lower investment performance. Higher uncertainty about the profit rate leads to a rise in investment performance.
38	Volatility and investment: interpreting evidence from developing countries	Aizenman and Marion (1999)	Average private and public investment as a share of GDP for 46 developing countries over 1970-1992 period.	The volatility index is the weighted average of standard deviations of residuals of fiscal, monetary and external variables as they are calculated from AR(1) processes. Correlation indices are examined and a disappointment aversion model is presented.	A significant negative correlation between volatility and private investment in developing countries is uncovered. This correlation dies out when the sum of private and public investment is used as an investment measure.
39	Measuring Uncertainty	Jurado et al. (2015)	Two datasets for the period 1959-2001, one of 132 US macroeconomic	The uncertainty is defined as the common variation in uncertainty across a number of series or the "conditional volatility of the purely unforecastable component of the future value of the series". The removal of	Much variability in the popular uncertainty proxies is not driven by uncertainty but belongs to forecastable fluctuations

	Title	Authors	Data	Methodology	Conclusions
			time series and one of 147 financial series.	the forecastable component of the series is emphasized and the measure of the macroeconomic uncertainty is constructed by the weighted average of the individuals' uncertainties. The measure is then compared to the common proxies of uncertainty. Finally, the relationship between the computed uncertainty and the real activity is examined using a VAR model.	in the time series. There is a strong and important relationship between uncertainty and real economy. The behaviour of the macro-uncertainty is countercyclical.
40	Political institutions and economic volatility	Klomp and de Haan (2009)	1960-2005 data for more than 110 countries classified in three different sets: type of regime, regime's stability, policy uncertainty	A dynamic panel model (unbalanced data) is estimated using a GMM estimator. Economic volatility is measured by the relative standard deviation of growth rate. The policy uncertainty has three dimensions: fiscal policy uncertainty, monetary policy uncertainty and trade policy uncertainty.	The relationship between democracy and economic volatility is negative. Economic volatility increases because of political instability and policy uncertainty.
41	The Effect of Uncertainty on Investment: Some Stylized Facts	Leahy and Whited (1995)	Data for 772 US manufacturing firms from 1981 to 1987	A linear regression of the rate of investment on various uncertainty measures is examined. and a VAR estimation method is adapted. Uncertainty is measured by the variance of the firm's daily stock return trying to capture the expectations related character of uncertainty.	Any increase in uncertainty leads to investment decrease. The correlation between uncertainty and investment is most likely explained by the irreversibility of investment.
42	Electoral Uncertainty, Fiscal Policy and Macroeconomic Fluctuations	Malley et al. (2005)	US quarterly data for consumption, investment, presidential approval rating covering the period 1947-2004.	A DSGE model is estimated to examine the link between electoral uncertainty and the macro-economy. The measure for the electoral uncertainty is the presidential approval rating provided by the Gallup Organization.	Short-sighted fiscal policies are followed by the governments in case of higher electoral uncertainty. The effect of electoral shocks on the output is statistically significant.
43	Economic Instability and Aggregate Investment	Pindyck and Solimano (1993)	GDP, capital stock, Labor, material inputs, wages data for a set of 30 countries over 1962-1989 period.	A model of industry equilibrium is employed. Uncertainty is measured by the volatility of marginal profitability of capital (sample standard deviation of the annual changes) which is calculated for a set of 30 countries using GDP and a Cobb-Douglas production function. A cross-section analysis give evidence of the relationship between investment and volatility.	Volatility changes affect moderately the investments and this effect is greater for the developing countries. Inflation is the only variable to be significantly correlated with the volatility of marginal profitability of capital.
44	Aggregate uncertainty, capacity utilization and manufacturing investment	Price (1995)	UK data over 1955-1992 for GDP and 1961-1992 for investment, capital stock, output, price index, treasury bill rate.	As a measure of the aggregate uncertainty, the conditional variance of GDP (GARCH-M) was used. The model of manufacturing investment is determined by the degree of capacity utilization and it was estimated from an error-correction form.	Aggregate uncertainty has a significant negative influence on manufacturing investment.
45	Cross-Country Evidence on the Link between Volatility and Growth	Ramey and Ramey (1995)	92 countries sample for the period 1960-1985 using GDP growth rate, population growth rate and the human capital. A second sample includes 24 OECD countries covering the period 1950-1988.	The relationship between growth and volatility is examined by regressing growth rate on standard deviation and a set of control variables not across time (cross-sectional). Another model takes into account both country and time-fixed effects (panel).	Higher volatility leads to to lower growth which is affected negatively by government-spending volatility.
46	How does private firms' investment respond to uncertainty?: Some evidence from the United Kingdom	Rashid (2011)	Unbalanced panel data for UK manufacturing firms over the 1999-2008 period (assets, debt, profits, sales).	A two step GMM estimation is employed in three different investment models. One model includes two types of uncertainty, a idiosyncratic uncertainty measured according to Morgan et al (2004) and an aggregate financial market uncertainty measured by the conditional variance of treasury bill rates using a GARCH model. The	Both types of uncertainty appear to have a negative impact on private firms' investment. The investment behaviour is more sensitive to the idiosyncratic uncertainty

	Title	Authors	Data	Methodology	Conclusions
				other two models include only each one of the two types of uncertainty.	than to the aggregate uncertainty.
47	Macroeconomic Uncertainty and the Impact of Oil Shocks	Robays (2012)	Oil data and world industrial production data from 1986 to 2011	A threshold VAR model is applied (TVAR, a two regime model) to examine the effect of macroeconomic uncertainty on the oil market. Macroeconomic uncertainty is proxied by the volatility in the world industrial production growth.	The model shows a nonlinear behaviour since it behaves differently in a regime of higher uncertainty. In this period of higher uncertainty the oil prices show a higher sensitivity to changes in oil production, thus the oil price elasticity decreases.
48	Private Investment and Political Institutions	Stasavage (2002)	Investment data for 74 developing countries over the 1980-1994 period.	Political institutions and uncertainty are cross-sensationally investigated through several pooled investment regressions. Checks and balances are measured using two political indices constructed by Henisz (2000) and Beck et al. (2001)	Check and balances in political institution appear to be on average a sufficient but not a necessary mechanism for governments to facilitate credibility and higher levels of private investments.
49	The Effect of Uncertainty on Investment , Hiring , and R & D : Causal Evidence from Equity Options	Stein and Stone (2012)	Unbalanced panel data (sales, investment, R&D etc) for US companies covering the period 2001-2011.	An instrumental variables strategy is followed in order to capture the sensitivity of industries to fluctuations in energy prices and exchange rates. The implied volatility i.e the standard deviation of future stock returns is used as an uncertainty measure.	Uncertainty acts negatively on capital investment, hiring and advertising but positively on R&D spending
50	Macroeconomic uncertainty and bank lending: The case of Ukraine	Talavera et al. (2012)	A balanced panel dataset for Ukrainian banks from 2003 to 2008 is used (profits, loans, assets, M1, M2, CPI, PPI)	A theoretical model based on the optimization of the bank value is proposed. Then a GMM estimator is applied on a panel of Ukrainian banks. GARCH models for monetary aggregate, CPI and PPI are used to measure the macroeconomic uncertainty.	Banks modify their lending policy when macroeconomic uncertainty changes. An increase (decrease) of macroeconomic uncertainty leads to a decrease (increase) of loans supply.

Table 2.18: Literature Review for Greece

	Title	Authors	Data	Methodology	Conclusions
1	Does Inflation Uncertainty Matter in Foreign Direct Investment Decisions? An Empirical Investigation for Portugal, Spain and Greece	Apergis and Katrakilidis (1998)	CPI, IP, M1, Nominal earnings to proxy wages, fixed capital inflows for Portugal, Spain and Greece from 1980 to 1995	The GARCH methodology is used to model uncertainty. Applying cointegration and error correction techniques the EC estimated equations and GARCH estimates are obtained. For each country the model includes two equations one for the inflation process and one for the conditional variance. Variance decomposition and impulse response analysis are employed.	The inflation uncertainty affects significantly the Foreign Direct Investment Decisions.
2	Dynamic Linkages between Output Growth and Macroeconomic Volatility : Evidence using Greek Data	Chapsa et al. (2011)	Quarterly data of IP and CI for Greece over the period 1966-2007.	An ECVAR model is used in conjunction with GARCH (1, 1) model to proxy for uncertainty. Next Granger causality test are applied to search for the causality effects.	The inflation uncertainty and the growth uncertainty, as measures of macroeconomic uncertainty, have negative effects on output growth.
3	Investment in Greek manufacturing under irreversibility and uncertainty: the message in used capital expenditures	Drakos and Goulas (2010)	An unbalanced panel of 22 Greek manufacturing sectors for a 9 year period (1993-2001) containing data for investments (4 types of assets: buildings, machines, vehicles, furniture), sales and production value. Macroseries include interest, marginal efficiency of capital and economic sentiment indicator (ESI).	Uncertainty is represented by the annual standard deviation of ESI. Sector specific irreversibility and asset specific irreversibility are examined and the respective equations are estimated by GMM dynamic panel method.	There is a non-uniform effect on investment and asymmetric responses to uncertainty depending on the degree of irreversibility of each type of asset.
4	Investment Decisions in Manufacturing: Assessing the effects of Real Oil Prices and their Uncertainty	Drakos and Konstantinou (2013)	Unbalanced panel of plant including data for investment, sales, cash flow, equity, loans and employment covering the period 1994-2005. Annual data on Brent is used to measure the oil price uncertainty.	To examine the effect of oil price uncertainty on investment decisions a GARCH (1,1) model is used.	Increases in real oil prices and their uncertainty have a significant negative impact on the probability of investment.
5	Inflation and Nominal Uncertainty: The case of Greece	Gibson and Balfoussia (2010)	CPI data for Greece covering the period 1981- 2008	GARCH models (GARCH, T-GARCH, C-GARCH) are employed to derive the measure of inflation uncertainty and an AR process is used to specify the conditional mean equation. Next, Granger causality tests are performed.	The sign of the causal effect is positive, thus higher levels of inflation increase the inflation uncertainty.
6	Estimating private savings behaviour in Greece	Hondroyiannis (2004)	Annual data for Greece from 1961-2000 for income, consumption, fertility rate, interest rate, liquidity, domestic credit, GDP, government fiscal balance, inflation.	A linear savings function is estimated using economic and demographic variables as independent variables. Inflation acts as a measure of macroeconomic uncertainty.	The precautionary saving motive is activated in periods of high inflation and the macroeconomic uncertainty as proxied by inflation has positive effects on the private savings behaviour in Greece.
7	Macroeconomic Uncertainty and Sectoral Output Performance: Empirical Evidence from Greece	Katrakilidis and Tabakis (2004)	CPI, Exchange rate, manufacturing and agricultural production for Greece over the period 1974-2000.	A VAR model is employed which includes four measures of uncertainty obtained from a GARCH method (inflation uncertainty, exchange rate uncertainty, agricultural uncertainty and industrial output uncertainty). Then a variance decomposition analysis is performed	The results reveal that macroeconomic uncertainty has a stronger impact on the agricultural sector and negative effects on sectoral growth.
8	Uncertainty Shocks in Eurozone Periphery Countries and Germany	Petrakis et al. (2014)	Daily stock market data, CPI, interest rates, IP for Greece, Portugal, Italy, Spain and Germany from 2001 to 2013	A global stock market index is used to proxy the global uncertainty. A rolling standard deviation of country's stock index is used to proxy the overall uncertainty. A VAR model and an impulse response analysis are	The uncertainty shocks have strong effects on economic activity and manufacturing. At the macro level an increased uncertainty may affect the monetary policy and at a micro level

	Title	Authors	Data	Methodology	Conclusions
				employed to assess the impact of uncertainty on activity.	investment and consumption are negatively affected.
9	Economic Uncertainties and their Impact on Activity in Greece compared with Ireland and Portugal	Schneider and Giorno (2014)	GDP, interests, employment, share price returns, stock index quarterly data over the 1993-2013 period for Greece, Ireland and Portugal.	An OLS regression is performed to check the relationship between uncertainty (proxied by the rolling st.dev. of stock index returns) the global uncertainty level and the output gap of each country. Then a VAR model is estimated and an impulse response analysis is applied to examine the link between uncertainty and activity.	The increase of uncertainty affects more negatively GDP in Greece than in Portugal and Ireland, though it is relatively small.
10	Parties , Elections and Stock Market Volatility : Evidence From a Small Open Economy	Siokis and Kapopoulos (2007)	Athens Stock Exchange data from 1987 to 2004.	An EGARCH-M model for stock prices is applied to capture the asymmetric effects on volatility of ASE.	Different political regimes and electoral effects have impact on the ASE index.
11	A Multivariate Model for the Relationship Between Agricultural Prices and Inflation Uncertainty: Evidence Using Greek Data	Tabakis (2001)	Exchange rate, M1, CPI, manufacturing production, indices of producer and purchase prices of agricultural products for Greece from 1981:1 to 1998:2.	A VAR model is employed which includes inflation uncertainty obtained from a GARCH model. Then a variance decomposition analysis is performed	There is a significant causal effect from inflation uncertainty to the agricultural prices with uncertainty explaining 15% of the variation in prices.
12	The Link between Output Growth and Real Uncertainty in Greece: A Tool to Speed up Economic Recovery?	Tsouma (2014)	GDP data for Greece from 1975 to 2013.	A GARCH-M model is applied in order to examine the bidirectional link between output growth and uncertainty.	Results indicate a significant negative relationship in both directions.

Table 2.19: Sectors' Descriptive Statistics

Time	Variable	Agriculture		Fishing		Mining		Manufacturing		Electricity		Trade		Construction	
		mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd
2000-2008	I/K	0.162	0.198	0.174	0.181	0.190	0.219	0.184	0.197	0.228	0.324	0.222	0.270	0.211	0.270
	CF/K	0.156	0.192	0.224	0.236	0.344	0.371	0.297	0.332	0.121	0.206	0.993	1.600	0.673	1.144
	GS/K	0.111	0.661	0.158	0.986	0.208	0.809	0.145	0.836	0.059	0.534	0.653	4.664	0.519	4.163
	id_{it}	1.088	1.976	1.394	1.543	1.582	2.598	2.066	3.445	7.236	30.217	13.891	23.969	9.274	20.568
	h_t	-1.044	1.119	-1.044	1.119	-1.044	1.119	-1.044	1.119	-1.044	1.119	-1.044	1.119	-1.044	1.119
2009-20014	I/K	0.100	0.166	0.088	0.167	0.067	0.192	0.094	0.163	0.149	0.286	0.112	0.237	0.106	0.242
	CF/K	0.154	0.199	0.165	0.326	0.224	0.353	0.205	0.324	0.169	0.252	0.664	1.551	0.475	1.118
	GS/K	0.053	0.696	0.117	1.123	-0.246	0.898	-0.234	0.890	0.030	0.462	-1.497	4.984	-0.886	4.310
	id_{it}	1.181	1.977	1.867	2.423	1.300	2.129	1.840	3.198	7.161	34.093	12.821	24.423	10.176	23.491
	h_t	2.423	1.495	2.423	1.495	2.423	1.495	2.423	1.495	2.423	1.495	2.423	1.495	2.423	1.495
Total Sample	I/K	0.134	0.186	0.139	0.180	0.137	0.216	0.145	0.188	0.185	0.307	0.172	0.261	0.161	0.262
	CF/K	0.155	0.195	0.201	0.276	0.294	0.369	0.260	0.332	0.149	0.235	0.853	1.588	0.584	1.137
	GS/K	0.083	0.679	0.140	1.047	0.004	0.879	-0.024	0.881	0.041	0.489	-0.338	4.932	-0.171	4.293
	id_{it}	1.144	1.977	1.677	2.126	1.411	2.328	1.931	3.301	7.175	33.129	13.225	24.251	9.848	22.475
	h_t	0.343	2.128	0.343	2.128	0.343	2.128	0.343	2.128	0.343	2.128	0.343	2.128	0.343	2.128

Time	Variable	Hotels		Transport		Financial		Real Estate		Education		Health		Community	
		mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd
2000-2008	I/K	0.156	0.184	0.227	0.303	0.235	0.444	0.194	0.264	0.231	0.286	0.259	0.282	0.246	0.322
	CF/K	0.110	0.122	0.926	1.841	2.470	4.489	0.632	1.507	0.769	1.488	1.238	2.059	0.394	1.027
	GS/K	0.012	0.121	0.827	5.905	1.098	4.726	0.056	2.566	0.070	2.244	0.501	1.459	0.273	1.745
	id_{it}	0.272	0.521	21.090	45.467	17.238	46.674	6.070	14.850	6.561	12.878	6.172	13.097	5.047	13.158
	h_t	-1.044	1.119	-1.044	1.119	-1.044	1.119	-1.044	1.119	-1.044	1.119	-1.044	1.119	-1.044	1.119
2009-20014	I/K	0.083	0.143	0.127	0.273	0.144	0.440	0.098	0.220	0.141	0.241	0.164	0.258	0.127	0.282
	CF/K	0.081	0.114	0.803	1.876	1.787	4.238	0.474	1.440	0.598	1.277	1.236	2.258	0.265	1.047
	GS/K	-0.029	0.130	-0.737	6.085	-0.259	4.690	-0.326	2.457	-0.693	2.637	-0.178	1.507	-0.413	1.823
	id_{it}	0.275	0.519	17.822	41.024	17.768	47.300	5.781	14.965	6.450	12.433	6.427	14.788	5.391	14.306
	h_t	2.423	1.495	2.423	1.495	2.423	1.495	2.423	1.495	2.423	1.495	2.423	1.495	2.423	1.495
Total Sample	I/K	0.126	0.172	0.179	0.293	0.193	0.444	0.145	0.247	0.187	0.269	0.210	0.274	0.189	0.309
	CF/K	0.098	0.119	0.868	1.859	2.123	4.376	0.556	1.477	0.689	1.395	1.237	2.164	0.334	1.038
	GS/K	-0.006	0.127	0.051	6.046	0.387	4.755	-0.147	2.516	-0.317	2.480	0.132	1.523	-0.065	1.817
	id_{it}	0.274	0.520	19.000	42.704	17.727	47.827	5.877	14.927	6.491	12.597	6.371	14.363	5.240	13.795
	h_t	0.343	2.128	0.343	2.128	0.343	2.128	0.343	2.128	0.343	2.128	0.343	2.128	0.343	2.128

Notes: Investment (I): Capital Expenditures in material fixed assets
Capital Stock (K): The lagged book value of total assets
Cash Flow (CF): Net profits plus depreciation
Growth of Sales (GS): Change is annual turnover
Idiosyncratic Uncertainty (id_{it}): Standard deviation of scaled sales estimated in a 5-year rolling window
Economic Uncertainty (h_t): The common unobserved factor
sd is the standard deviation.
The variables are trimmed at the 5st and 95th percentile to reduce the effect of outliers.

Table 2.20: GMM Estimates of Investment Rate – Sector level

Variable	Agriculture	Fishing	Mining	Manufacturing	Electricity	Trade	Construction	Hotels	Transport	Financial	Real Estate	Education	Health	Community
$(I/K)_{i.t-1}$	0.146*	0.168**	0.243**	0.151***	0.135**	0.075***	0.133***	0.073**	0.107***	-0.067	0.077	0.086	0.069*	0.119***
	(0.082)	(0.075)	(0.108)	(0.023)	(0.064)	(0.015)	(0.038)	(0.034)	(0.035)	(0.067)	(0.084)	(0.076)	(0.042)	(0.044)
$(CF/K)_{i.t-1}$	-0.030	0.402***	0.293*	0.184***	-0.263	0.067***	0.207**	-0.379	0.250***	0.016	0.563*	0.134***	0.113***	0.263**
	(0.393)	(0.140)	(0.165)	(0.063)	(0.211)	(0.020)	(0.087)	(0.693)	(0.085)	(0.017)	(0.296)	(0.045)	(0.022)	(0.126)
$(GS/K)_{i.t-1}$	0.137**	-0.047**	-0.100**	-0.028	-0.096	0.029***	-0.030**	1.733**	-0.013	0.007	0.088*	-0.046**	-0.014	-0.061**
	(0.060)	(0.024)	(0.041)	(0.034)	(0.103)	(0.008)	(0.014)	(0.835)	(0.011)	(0.007)	(0.046)	(0.020)	(0.013)	(0.030)
h_{t-1}	-0.018**	-0.025***	-0.018**	-0.032***	-0.018***	-0.025***	-0.019***	-0.048***	-0.019***	-0.024*	-0.046***	-0.022**	-0.022***	-0.021***
	(0.008)	(0.009)	(0.008)	(0.002)	(0.005)	(0.002)	(0.004)	(0.009)	(0.005)	(0.014)	(0.009)	(0.011)	(0.005)	(0.008)
$id_{i.t-1}$	-0.066**	0.095*	0.050	-0.063***	-0.009***	-0.005***	-0.002	-2.409***	0.001	0.002*	-0.091**	-0.006*	0.002	-0.000
	(0.032)	(0.057)	(0.045)	(0.013)	(0.001)	(0.001)	(0.002)	(0.716)	(0.001)	(0.001)	(0.041)	(0.003)	(0.002)	(0.005)
Wald test	0.004	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.005	0.000	0.001	0.000	0.000
AR(2) test	-0.680	0.676	-1.312	0.812	0.365	-0.601	-0.133	-1.118	-0.980	1.407	0.104	-0.231	1.671	0.599
AR(2)	0.496	0.499	0.189	0.417	0.715	0.548	0.894	0.263	0.327	0.159	0.917	0.817	0.095	0.549
J (Sargan/Hansen) test	7.199	39.825	30.113	0.044	5.800	1.708	3.350	1.522	4.687	87.996	2.347	26.445	39.998	11.523
J. *p*-value	0.206	0.478	0.744	0.978	0.832	0.789	0.851	0.467	0.698	0.480	0.799	0.233	0.721	0.905
Number of Instruments	11	46	42	8	16	10	13	8	13	94	11	28	52	25
Observations	3105	1605	1965	86220	3375	144180	29505	46830	21855	6705	16425	4050	9075	9240

Notes: The models are estimated using the first-difference Arellano-Bond estimator developed by Arellano and Bond (1991) and implemented in STATA 14 by Roodman (2009). Robust standard errors are reported in braces. Sargan–Hansen J-test is a test of overidentifying restrictions. AR (2) is the Arellano and Bond (1991) test for second order serial correlation. Robust standard errors are computed using the Windmeijer (2005) WC-robust two-step estimator. Instrument sets of the second through sixth lags of the right hand variables are used for the differenced equations. To avoid instrument proliferation we invoke the "collapse" option in order to restrict the lag ranges in the generation of the instruments sets. The *h* term is the measure of economic uncertainty. while the *id* term refers to the idiosyncratic uncertainty of each firm. To eliminate the effect of outliers the data are screened by trimming observations at the 1st and 99th percentile. The following tests are applied: 1. Sargan-Hansen J-test as a test of overidentifying restrictions. 2. The difference-in-Hansen tests of exogeneity and validity of instrument subsets (not reported but available on request). 3. The Arellano and Bond (1991) test for second order serial correlation and 4. The Wald chi-squared statistic of the null hypothesis that all the coefficients except the constant are zero. * significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level

Table 2.21:GMM Estimates of Investment Rate – Small Firms ≤ p25

Variable	Agriculture	Fishing	Mining	Manufacturing	Electricity	Trade	Construction	Hotels	Transport	Financial	Real Estate	Education	Health	Community
$(I/K)_{i.t-1}$	0.149**	-0.062	0.384**	0.100**	-0.586**	-0.019	-0.285***	-0.151	-0.078***	-0.307***	-0.144*	-0.307**	-0.213**	-0.137
	(0.069)	(0.106)	(0.181)	(0.044)	(0.245)	(0.047)	(0.047)	(0.161)	(0.029)	(0.110)	(0.077)	(0.153)	(0.092)	(0.117)
$(CF/K)_{i.t-1}$	0.409	0.262	0.906***	-0.368**	-0.100	0.282*	-0.014	-3.587	0.008	-0.002	0.761**	0.049***	0.053***	0.056**
	(0.454)	(0.421)	(0.136)	(0.167)	(0.238)	(0.144)	(0.067)	(4.335)	(0.040)	(0.008)	(0.383)	(0.017)	(0.017)	(0.026)
$(GS/K)_{i.t-1}$	0.094	0.465***	0.201***	0.028	-0.090	-0.056**	0.005	6.748**	-0.004	0.000	-0.383**	0.046	0.018	-0.063*
	(0.089)	(0.089)	(0.054)	(0.030)	(0.199)	(0.028)	(0.010)	(3.178)	(0.005)	(0.005)	(0.188)	(0.039)	(0.015)	(0.036)
h_{t-1}	-0.040**	-0.011**	0.134***	-0.041***	-0.008**	-0.031***	-0.032**	-0.060***	-0.020**	-0.038**	-0.017***	-0.039***	-0.072***	-0.046**
	(0.021)	(0.005)	(0.041)	(0.005)	(0.003)	(0.011)	(0.014)	(0.021)	(0.010)	(0.019)	(0.005)	(0.015)	(0.023)	(0.023)
$id_{i.t-1}$	-0.475***	-0.426**	0.033***	-0.023**	-0.385	0.001	-0.002***	-9.459***	-0.021***	-0.022***	0.117***	0.060**	0.012***	-0.076*
	(0.126)	(0.206)	(0.011)	(0.010)	(0.469)	(0.004)	(0.001)	(3.605)	(0.008)	(0.007)	(0.006)	(0.028)	(0.004)	(0.045)
Wald test	0.000	0.000	0.000	0.000	0.000	0.003	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.027
AR(2) test	-1.152	0.585	-1.034	0.147	-0.775	-1.457	-1.049	0.040	-0.624	-0.452	-1.611	-1.035	-0.298	-1.420
AR(2)	0.249	0.559	0.301	0.883	0.438	0.145	0.294	0.968	0.533	0.651	0.107	0.301	0.766	0.156
J (Sargan/Hansen) test	0.161	1.662	2.355	7.682	4.007	3.855	60.984	1.759	19.893	21.660	26.663	11.700	18.624	35.584
J. *p*-value	0.923	1.000	0.993	0.741	1.000	0.696	0.440	0.624	0.648	0.989	0.774	1.000	0.999	0.968
Number of Instruments	8	27	16	17	28	12	66	9	29	45	39	40	47	59
Observations	511	271	339	14292	390	20803	4153	8093	3136	984	2215	626	1182	1309

Notes: The models are estimated using the first-difference Arellano-Bond estimator developed by Arellano and Bond (1991) and implemented in STATA 14 by Roodman (2009). Robust standard errors are reported in braces. Sargan–Hansen J-test is a test of overidentifying restrictions. AR (2) is the Arellano and Bond (1991) test for second order serial correlation. Robust standard errors are computed using the Windmeijer (2005) WC-robust two-step estimator. Instrument sets of the second through sixth lags of the right hand variables are used for the differenced equations. To avoid instrument proliferation we invoke the “collapse” option in order to restrict the lag ranges in the generation of the instruments sets. The *h* term is the measure of economic uncertainty. while the *id* term refers to the idiosyncratic uncertainty of each firm. To eliminate the effect of outliers the data are screened by trimming observations at the 1st and 99th percentile. The following tests are applied: 1. Sargan-Hansen J-test as a test of overidentifying restrictions. 2. The difference-in-Hansen tests of exogeneity and validity of instrument subsets (not reported but available on request). 3. The Arellano and Bond (1991) test for second order serial correlation and 4. The Wald chi-squared statistic of the null hypothesis that all the coefficients except the constant are zero. * significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level

Table 2.22: GMM Estimates of Investment Rate – Large Firms ≥ p75

Variable	Agriculture	Fishing	Mining	Manufacturing	Electricity	Trade	Construction	Hotels	Transport	Financial	Real Estate	Education	Health	Community
$(I/K)_{i.t-1}$	0.059	0.232	-0.253	0.125***	0.481***	0.132***	0.152***	0.254***	0.137**	-0.094	0.267**	-0.263**	-0.058	0.142
	(0.107)	(0.402)	(0.252)	(0.040)	(0.004)	(0.025)	(0.059)	(0.095)	(0.063)	(1.748)	(0.132)	(0.131)	(0.116)	(0.122)
$(CF/K)_{i.t-1}$	-0.196**	-0.169	0.270**	-0.212	-0.007***	-0.015	0.029	0.400	0.059***	0.014	-0.170***	-0.298**	0.258***	0.180**
	(0.088)	(0.838)	(0.127)	(0.161)	(0.001)	(0.042)	(0.080)	(0.836)	(0.010)	(0.108)	(0.065)	(0.129)	(0.100)	(0.089)
$(GS/K)_{i.t-1}$	0.031***	0.038	-0.013	0.214***	0.000	0.008**	0.009	-2.262**	0.003	-0.016	-0.045***	0.046	-0.000	0.030
	(0.009)	(0.036)	(0.044)	(0.077)	(0.000)	(0.004)	(0.012)	(1.112)	(0.005)	(0.336)	(0.015)	(0.042)	(0.041)	(0.039)
h_{t-1}	-0.016*	-0.059***	-0.031***	-0.028***	0.003***	-0.030***	-0.018***	-0.064***	-0.019***	-0.003	-0.089***	-0.019**	-0.030**	-0.041**
	(0.008)	(0.022)	(0.011)	(0.004)	(0.001)	(0.003)	(0.005)	(0.015)	(0.007)	(0.276)	(0.031)	(0.009)	(0.012)	(0.017)
$id_{i.t-1}$	-0.010	0.385***	-0.017	-0.085***	0.006***	-0.003***	-0.016**	-0.345	-0.001	0.005	-0.034	0.010	-0.025***	-0.087**
	(0.007)	(0.132)	(0.044)	(0.028)	(0.000)	(0.001)	(0.008)	(0.241)	(0.002)	(0.127)	(0.047)	(0.010)	(0.008)	(0.036)
Wald test	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
AR(2) test	0.001	0.405	-1.175	0.017	0.000	-0.026	1.849	-1.521	-0.862	-0.182	-1.326	-2.007	-0.908	-0.150
AR(2)	0.999	0.686	0.240	0.987	1.000	0.980	0.064	0.128	0.389	0.856	0.185	0.045	0.364	0.881
J (Sargan/Hansen) test	23.271	3.248	7.096	0.997	1.058	37.620	42.760	2.325	13.625	0.000	4.572	26.726	23.569	13.924
J. *p*-value	0.994	1.000	0.998	0.802	0.304	0.487	0.438	0.940	0.849	1.000	0.600	0.731	0.486	0.604
Number of Instruments	49	32	27	9	7	44	48	13	26	9	12	38	30	22
Observations	539	281	352	14863	404	21634	4318	8416	3260	1022	2509	650	1228	1360

Notes: The models are estimated using the first-difference Arellano-Bond estimator developed by Arellano and Bond (1991) and implemented in STATA 14 by Roodman (2009). Robust standard errors are reported in braces. Sargan–Hansen J-test is a test of overidentifying restrictions. AR (2) is the Arellano and Bond (1991) test for second order serial correlation. Robust standard errors are computed using the Windmeijer (2005) WC-robust two-step estimator. Instrument sets of the second through sixth lags of the right hand variables are used for the differenced equations. To avoid instrument proliferation we invoke the "collapse" option in order to restrict the lag ranges in the generation of the instruments sets. The *h* term is the measure of economic uncertainty. while the *id* term refers to the idiosyncratic uncertainty of each firm. To eliminate the effect of outliers the data are screened by trimming observations at the 1st and 99th percentile. The following tests are applied: 1. Sargan-Hansen J-test as a test of overidentifying restrictions. 2. The difference-in-Hansen tests of exogeneity and validity of instrument subsets (not reported but available on request). 3. The Arellano and Bond (1991) test for second order serial correlation and 4. The Wald chi-squared statistic of the null hypothesis that all the coefficients except the constant are zero. * significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level

Table 2.23: GMM Estimates of Investment Rate – Manufacturing two-digit (NACE Rev. 1.1 & ISIC 3.1) Subsectors

Variable	Food & Beverages	Textiles	Wearing	Leather	Wood	Paper	Publishing & Printing	Coke & Petroleum	Chemicals	Rubber & Plastic
$(I/K)_{i.t-1}$	0.119***	0.079	0.130***	0.127	0.196***	0.034	0.142**	0.284*	0.140***	0.169***
	(0.029)	(0.051)	(0.049)	(0.115)	(0.073)	(0.074)	(0.066)	(0.167)	(0.049)	(0.061)
$(CF/K)_{i.t-1}$	0.489***	-0.487*	0.163	0.216*	0.422**	-0.669**	-0.054	0.694***	-0.105	0.462***
	(0.171)	(0.273)	(0.151)	(0.126)	(0.191)	(0.294)	(0.221)	(0.152)	(0.112)	(0.174)
$(GS/K)_{i.t-1}$	0.032	-0.004	-0.089**	-0.035	-0.017	0.282**	0.075	0.172***	0.070***	-0.173***
	(0.037)	(0.075)	(0.038)	(0.023)	(0.051)	(0.135)	(0.067)	(0.058)	(0.021)	(0.062)
h_{t-1}	-0.016***	-0.042***	-0.028***	-0.036***	-0.023**	-0.044***	-0.038***	-0.047***	-0.030***	-0.019***
	(0.002)	(0.013)	(0.008)	(0.011)	(0.010)	(0.011)	(0.009)	(0.016)	(0.005)	(0.006)
$id_{i.t-1}$	0.009**	-0.034	-0.003	-0.015	0.001	-0.046**	-0.055**	-0.009	-0.014***	-0.007
	(0.005)	(0.058)	(0.007)	(0.047)	(0.006)	(0.019)	(0.023)	(0.008)	(0.005)	(0.011)
Wald test	0.000	0.000	0.000	0.000	0.000	0.003	0.000	0.000	0.000	0.000
AR(2) test	0.216	-0.927	-1.101	0.322	1.369	-1.625	1.552	0.494	-0.091	-1.569
AR(2)	0.829	0.354	0.271	0.748	0.171	0.104	0.121	0.621	0.928	0.117
J (Sargan/Hansen) test	8.911	1.940	4.848	26.644	5.624	8.193	1.592	2.742	4.631	2.629
J. *p*-value	0.350	0.857	0.563	0.959	0.689	0.610	0.902	0.950	0.796	0.622
Number of Instruments	14.000	11.000	12.000	47.000	14.000	16.000	11.000	14.000	14.000	10.000
Observations	21480	3300	4545	795	1905	2475	7980	495	5025	5040

Notes: The models are estimated using the first-difference Arellano-Bond estimator developed by Arellano and Bond (1991) and implemented in STATA 14 by Roodman (2009). Robust standard errors are reported in braces. Sargan–Hansen J-test is a test of overidentifying restrictions. AR (2) is the Arellano and Bond (1991) test for second order serial correlation. Robust standard errors are computed using the Windmeijer (2005) WC-robust two-step estimator. Instrument sets of the second through sixth lags of the right hand variables are used for the differenced equations. To avoid instrument proliferation we invoke the "collapse" option in order to restrict the lag ranges in the generation of the instruments sets. The *h* term is the measure of economic uncertainty. while the *id* term refers to the idiosyncratic uncertainty of each firm. To eliminate the effect of outliers the data are screened by trimming observations at the 1st and 99th percentile. The following tests are applied: 1. Sargan-Hansen J-test as a test of overidentifying restrictions. 2. The difference-in-Hansen tests of exogeneity and validity of instrument subsets (not reported but available on request). 3. The Arellano and Bond (1991) test for second order serial correlation and 4. The Wald chi-squared statistic of the null hypothesis that all the coefficients except the constant are zero. * significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level

Variable	Non-Metallic	Basic Metals	Fabricated Metals	Machinery &	Electrical Machinery	Radio, TV & Comms	Medical Instruments	Motor Vehicles	Transport Equipment	Furniture	Recycling
$(I/K)_{i.t-1}$	0.239***	0.181**	0.315***	0.164**	-0.227	-0.050	-0.040	0.016	0.088	0.126***	0.295**
	(0.069)	(0.082)	(0.091)	(0.082)	(0.223)	(0.196)	(0.155)	(0.093)	(0.233)	(0.048)	(0.149)
$(CF/K)_{i.t-1}$	0.283***	-0.299**	0.679***	0.151	0.399**	0.621*	-0.070	0.024	-0.471*	0.798***	0.282
	(0.101)	(0.151)	(0.257)	(0.254)	(0.188)	(0.322)	(0.246)	(0.163)	(0.275)	(0.231)	(0.322)
$(GS/K)_{i.t-1}$	-0.164**	0.059**	-0.318***	0.088**	-0.066**	-0.023	-0.012	-0.231**	0.157*	-0.154***	-0.028
	(0.064)	(0.025)	(0.080)	(0.045)	(0.031)	(0.094)	(0.051)	(0.108)	(0.088)	(0.060)	(0.057)
h_{t-1}	-0.027***	-0.025***	-0.028***	-0.033***	-0.005	-0.030*	-0.032**	-0.046***	-0.033*	-0.025***	-0.024**
	(0.006)	(0.008)	(0.007)	(0.007)	(0.013)	(0.017)	(0.015)	(0.012)	(0.019)	(0.009)	(0.011)
$id_{i.t-1}$	0.022*	0.001	0.003	-0.093**	0.064***	-0.325**	-0.023**	-0.081***	0.083	0.042	0.100**
	(0.012)	(0.007)	(0.013)	(0.041)	(0.022)	(0.163)	(0.012)	(0.029)	(0.140)	(0.027)	(0.045)
Wald test	0.000	0.000	0.000	0.000	0.000	0.327	0.039	0.000	0.018	0.000	0.001
AR(2) test	1.041	-1.583	0.018	0.831	-1.643	-0.947	-0.763	-1.396	-0.183	-0.284	0.734
AR(2)	0.298	0.114	0.986	0.406	0.100	0.344	0.445	0.163	0.854	0.776	0.463
J (Sargan/Hansen) test	4.267	18.626	12.528	5.564	2.644	0.911	7.254	3.481	0.001	8.943	11.172
J. *p*-value	0.749	0.231	0.129	0.591	0.619	0.823	0.403	0.901	0.982	0.257	0.429
Number of Instruments	13.000	21.000	14.000	13.000	10.000	9.000	13.000	14.000	7.000	13.000	17.000
Observations	7455	1275	8685	4485	1725	420	750	585	1410	4785	1260

Notes: The models are estimated using the first-difference Arellano-Bond estimator developed by Arellano and Bond (1991) and implemented in STATA 14 by Roodman (2009). Robust standard errors are reported in braces. Sargan–Hansen J-test is a test of overidentifying restrictions. AR (2) is the Arellano and Bond (1991) test for second order serial correlation. Robust standard errors are computed using the Windmeijer (2005) WC-robust two-step estimator. Instrument sets of the second through sixth lags of the right hand variables are used for the differenced equations. To avoid instrument proliferation we invoke the "collapse" option in order to restrict the lag ranges in the generation of the instruments sets. The *h* term is the measure of economic uncertainty. while the *id* term refers to the idiosyncratic uncertainty of each firm. To eliminate the effect of outliers the data are screened by trimming observations at the 1st and 99th percentile. The following tests are applied: 1. Sargan-Hansen J-test as a test of overidentifying restrictions. 2. The difference-in-Hansen tests of exogeneity and validity of instrument subsets (not reported but available on request). 3. The Arellano and Bond (1991) test for second order serial correlation and 4. The Wald chi-squared statistic of the null hypothesis that all the coefficients except the constant are zero. * significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level

Chapter 3

Investment and uncertainty: Are large firms different from small ones?

Abstract

We examine the effect of uncertainty on investment by employing panel data from 25000 Greek firms' balance sheets. The sample period allows us to consider turbulent and tranquil periods. Uncertainty is proxied by a dynamic factor model. We explore the heterogeneity among the sectors within a panel quantile estimation framework. This allows us to differentiate between relatively low and relatively high values of investment. We reveal the different responses between and within sectors. At aggregate level the effect of uncertainty is negative. This negative effect increases substantially when the firm's investment rate is relatively high. The negative impact of uncertainty is more profound for smaller firms.

JEL classification: C23; D22; D81; D92; G31

Keywords: Greek firms, Uncertainty, Volatility, Quantile Regression, Panel data

3.1 Introduction

The effect of uncertainty on economic activity has been an important issue. More than one way of measuring uncertainty have been proposed (see Jurado et al. (2015)). The topic has received significant attention from academics, researchers and policy makers since the beginning of the financial crisis. Uncertainty can vary through the business cycles and can affect a firm's investment decisions. The theoretical strand of the literature has identified positive and negative effects of uncertainty. On the other hand, a large body of the empirical literature suggests a negative relationship. However, the heterogeneous effect of uncertainty on investment across the quantiles of the conditional distribution of the latter has not been thoroughly examined.

This paper quantifies the investment loss due to uncertainty. [22] We consider an economy that has faced increased uncertainty. Greece provides a useful case study for this investigation since it experienced a prolonged economic recession and turbulent periods of increased uncertainty. We employ a dataset that includes 25000 Greek firms' balance sheets covering all sectors and different firm sizes. A panel quantile estimation framework is employed to obtain a comprehensive picture of the heterogeneous effect of uncertainty. We address this heterogeneity across quantiles for each of the sectors. The results reveal a negative effect of uncertainty on investment. Furthermore, quantile regressions provide evidence of a within-sector heterogeneity based on the firm's investment rates. Firms that invest more face amplified uncertainty effects. They are more vulnerable to the impact of uncertainty. On the other side firms with lower investment rates are affected less. A classification based on the firms' annual turnover gives a better overall picture of the heterogeneity across quantiles. Smaller firms that invest more are the most affected. Digging a bit deeper, at the sectoral level, we find that the magnitude of the negative uncertainty effect varies across and within sectors.

Our paper relates to the growing empirical literature of investment under uncertainty. To our knowledge, it is the first that examines the different effects of uncertainty on relatively large

[22] We focus on economy-wide uncertainty proxied by the common unobserved factor of a dynamic factor model applied on a set of 9 economic indicators from 1994M01 to 2015M08.

and relatively small firms. We apply quantile estimation techniques to gauge the uncertainty impact and the investment response. The main contribution of this paper is to estimate the investment loss due to uncertainty for different investment levels. We address the following question: what is the uncertainty effect for the less/more exposed firms in terms of investment rate?

The paper is organized as follows: Section 3.2 reviews the literature. Section 3.3 outlines the econometric specification and Section 3.4 presents the data and the measures of uncertainty. The results are presented in Section 3.5. The last one concludes and provides policy implications.

3.2 Literature review

One of the first discussions on the modern concept of uncertainty belongs to Knight (1921). The Knightian uncertainty was an initial approach to distinguish between uncertainty and risk and it described the situation where the knowledge about the probability distribution is limited or incomplete. Keynes (1937) expressed also the same suggestion in his famous quote: *"We simply don't know"*. Their work nurtured a rich theoretical literature about the effects of uncertainty. The precautionary motive theory, the Oi-Hartman-Abel effects theory, and the growth options mechanism suggest a positive sign for the uncertainty effect. The risk aversion behavior and the real options of irreversible investment lead to a negative impact of uncertainty. [23] The majority of the theoretical approaches focus on the real options theory and are reviewed in the seminal work of Dixit and Pindyck (1994).

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[23] For Keynes, the precautionary motive is one of the three mechanisms that drive liquidity preferences (the others are the transaction and speculative motives). The Oi-Hartman-Abel theory, based on the models of Abel (1983); Hartman (1972); Oi (1961), states that in the case of convex profits more uncertainty will lead to increased expected profits since prices with greater variability get more probability weight. The growth options mechanism describes the situation of increased expected profits and stimulated investment activity because of an increase in uncertainty. The risk aversion theory supports the connection between increasing uncertainty and increased risk premium which leads to an increased cost of finance with negative effects on investment decisions. The real options theory (Bernanke (1983); Black and Scholes (1973); Cox and Ross (1976); Merton (1973)) is based on the assumption that investment projects take place in conditions of irreversibility and any new information over time provides the investor the option to delay the project.

On the empirical side, most studies indicate a negative relationship between uncertainty and investment. Uncertainty can undermine investment and could affect business decisions. The empirical literature, until the early 2000s, is reviewed in Carruth et al. (2000), Lensink et al. (2001), and Butzen and Fuss (2003). For a more recent reviews see Forbes (2016) and Panagiotidis and Printzis (2019)[24]. Influential works include Bond et al. (2005), Bloom et al. (2007, 2019), Baum et al. (2008), Bloom (2009), Baker et al. (2013), and Henzel and Rengel (2013). Table 3.6 in the Appendix summarizes the latest studies. A popular approach in empirical modelling followed by many studies is based on Tobin's *q* theory of investment, where the *q*-ratio of the market value of assets to its book value relates investment to the firm's market valuation. This is considered as an index of the firm's investment behavior (Tobin, 1969). The empirical strategy usually employs a dynamic investment model estimated using procedures that rely on GMM techniques such as Arellano and Bond (1991) and Blundell and Bond (1998). We will follow a similar approach but within a different estimation framework based on panel quantile regression method. This allows us to model the entire conditional distribution of the response variable and estimate the effect of uncertainty for different levels of investment (high and low). The latter avoids simplistic approaches that are based on sub-sample regressions. The literature on quantile regression methods for panel data is still growing. A recent contribution to the investment literature that adopts panel quantile estimation techniques includes Akron et al. (2020) and Koc and Sahin (2017).

3.3 Empirical Specification

3.3.1 Estimation technique – Panel Quantile Regression

We employ a panel quantile regression framework for two reasons. First, quantile regression models are more robust to outliers and perform better in conditions of non-normality. Second, such models take into account the impact of the covariates on the entire conditional distribution of the response variable and provide a more accurate description of the relationship. As a result, we can obtain a more comprehensive picture of the heterogeneity of the effect of uncertainty on investment. Quantile estimation for the cross-section case was originally introduced by Koenker and Bassett (1978) and extended to the case of longitudinal

[24] Panagiotidis and Printzis (2019) also present the existing literature that focuses on Greece which is limited.

data in Koenker (2004). The model specification for the conditional quantile functions[25] is given by:

$$Q_{y_{it}}(\tau|x_{it}) = c_i + x_{it}'\beta(\tau) \quad i = 1, \dots, N\,; \;\; t = 1, \dots, T \tag{1}$$

where $Q_{y_{it}}(\tau|x_{it})$ is the τth conditional quantile function of the response of the tth observation on the ith individual y_{it} , c_i is a fixed effect acting as a pure location shift independent of τ and $x_{it}'\beta(\tau)$ the covariates that depend upon the quantile τ. If a lag of the response variable y_{it-1} is present as a regressor the model takes the dynamic form:

$$Q_{y_{it}}(\tau|x_{it}) = c_i + y_{it-1}a(\tau) + x_{it}'\beta(\tau) \quad i = 1, \dots, N\,; \;\; t = 1, \dots, T \tag{2}$$

Following Koenker (2004) to estimate the model one could solve:

$$(\hat{c}, \hat{\alpha}, \hat{\beta}) = \min_{c,a,\beta} \sum_{k=1}^{Q} \sum_{i=1}^{N} \sum_{t=1}^{T} u_k \rho_\tau \times (y_{it} - c_i - y_{it-1}a(\tau_k) - x_{it}'\beta(\tau_k)) \tag{3}$$

where $\rho_\tau(u) = u(\tau - I(u < 0))$ is the quantile loss function of Koenker and Bassett (1978) and u_k are the weights controlling the relative influence of the Q quantiles $\{\tau_1, \dots, \tau_Q\}$ on the estimations of the parameters c_i. Galvao (2011) argues that (3) suffers from bias because of the presence of the lagged dependent variable y_{it-1} and proposes the use of instrumental variables to produce a consistent estimator. His method follows Chernozhukov and Hansen (2005, 2006, 2008) using lagged regressors as an instrument. Canay (2011) adopted a simpler approach for the static model through data transformation that eliminates the fixed effects c_i as $T \to \infty$. This is a two-step estimation method. Fixed effects regression is applied to estimate the unobserved fixed effects. In the second step, the fitted variable is used in a quantile regression to estimate $\beta(\tau)$. However, in the case of short panels with small T the estimation of fixed effects is no longer consistent (this case is closer to the dataset we will employ later on).[26] Rosen (2009), Ponomareva (2011), and Kato et al. (2012) take into account this problem and provide alternative specifications. Machado and Santos Silva (2019) propose a restricted

[25] According to Koenker and Hallock (2001) conditional quantile functions are the "….models in which quantiles of the conditional distribution of the response variable are expressed as functions of observed covariates."
[26] The approach of Sarafidis and Weber (2015) and Christodoulou and Sarafidis (2017) could also be considered in this case.

version of the standard formulation of $Y_{it} = X'_{it}\beta(U'_{it}),\ U'_{it} \sim Uniform\,(0,1)$ based on conditional means which allows for nonlinear quantile effects and allows the individual effects to affect the entire distribution. Powell (2014) introduces an estimator with non-additive fixed effects. The main advantage of this approach is that it is consistent for small T and that it bypasses the specification of the fixed effects. The estimation uses GMM allowing the instruments to be arbitrarily correlated with the non-additive fixed effects. It also provides consistent estimates for the dynamic case where a lagged dependent variable is present. Following the notation of Powell (2014), the model is:

$$Y_{it} = D'_{it}\beta(U^*_{it}) \tag{4}$$

where D are the treatment variables, $U^*_{it} \sim U(0,1)$ and $U^*_{it} = f(c_i, U_{it})$. The function $f(\cdot)$ is unknown and the individual fixed effects c_i are not estimated. U_{it} acts as a rank variable and is a representation of proneness for the outcome thus, U^*_{it} is a function of a fixed and a random proneness. It is worth mentioning that (4) is comparable to pooled instrumental variables quantile regression but not to additive fixed effects model. The latter estimate the distribution of $(Y_{it} - c_i)|D_{it}$ instead of $Y_{it}|D_{it}$. Thus, pooled quantile regression provides a similar interpretation of the parameters and can be used as a robustness test [27].

3.3.2 Empirical model

We estimate an augmented standard investment model in the spirit of Baum et al. (2008). According to Powell (2014), the quantile regression specification and the structural quantile function is:

$$\left(\frac{I}{K}\right)_{it}(\tau) = \alpha_1(\tau)\left(\frac{I}{K}\right)_{it-1} + \alpha_2(\tau)\left(\frac{CF}{K}\right)_{it-1} + \alpha_3(\tau)\left(\frac{GS}{K}\right)_{it-1} + \alpha_4(\tau)id_{i,t-1} + \beta(\tau)h_{t-1} \tag{5}$$

where I is the investment, K the capital stock, CF the cash flow, GS the growth of sales, $id_{i,t}$ the idiosyncratic uncertainty, h_t the economic uncertainty. $\left(\frac{I}{K}\right)_{it}(\tau)$ expresses the conditional distribution for any given $\tau \in (0,1)$. High (low) values indicate firms with relative strong (weak)

[27] Recent theoretical work includes also Galvao and Kato (2016); Geraci and Bottai (2007); Graham et al. (2016); Lamarche (2010) .

investment performance. To account for the past investment behavior and the lagged investment effect, we include the lagged investment rate $\left(\frac{I}{K}\right)_{it-1}$ in the model. *CF* and *GS* variables reflect the firms' investment opportunities and the growth potential.[28] Following studies in this strand of the literature, we use a model of investment that includes the growth of sales ratio.[29] The main reason is that we use a full-range sample, in terms of firm size, with limited availability of stock market data. The alternative approach that could provide computable *q* measures was to select a sample of large stock-market firms. This would reduce the sample and the coverage of the Greek firms' investment behavior would be restricted. The uncertainty measure enter the model with their first lags to control for lags in decision making (manager's analyse information acquired from the previous period). A two-step GMM method is used to estimate parameters. Instruments are obtained from inside the model following the idea that regressors are correlated with their lagged values but not with the innovations.[30] Thus, we can use lagged regressors as instruments. The estimation is based on the Markov Chain Monte Carlo (MCMC) optimization method.[31]

3.4 Data and Uncertainty proxy

3.4.1 Measuring Uncertainty

A dynamic factor model is employed to take into account the time series dimension of the data and to reveal the common unobserved factor which will be used as the proxy of economic uncertainty. The equations of the dynamic factor model are:

$$y_t = Af_t + Bx_t + u_t \quad (6)$$

$$f_t = Cw_t + D_1 f_{t-1} + D_2 f_{t-2} + \cdots + D_{t-p} f_{t-p} + \varepsilon_t \quad (7)$$

$$u_t = E_1 u_{t-1} + E_2 u_{t-2} + \cdots + E_{t-q} u_{t-q} + \nu_t \quad (8)$$

[28] Baum et al (2010) were among the first to examine the interaction between cash flow and uncertainty. Section 6 considers their interaction.

[29] See among others: Asker et al. (2011); Badertscher et al. (2013); Bo (1999); Bond et al. (2005); Ghosal and Loungani (2000); Rashid (2011); Rashid and Saeed (2017); Whited and Wu (2006).

[30] See Anderson and Hsiao (1981), (1982); Arellano and Bond (1991).

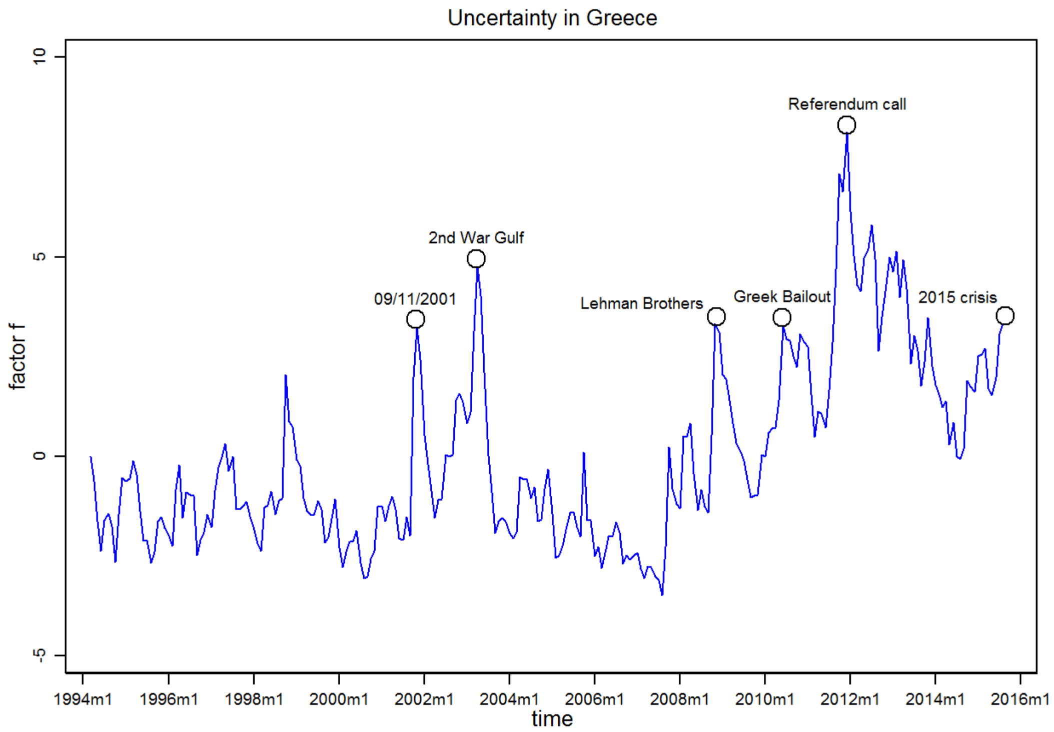
[31] The model is estimated using a two-step GMM method developed by Powell (2014) and implemented in STATA (*qregpd* package). The optimization method employs adaptive MCMC sampling by the use of a multivariate normal proposal distribution. The MCMC algorithm works through acceptance-rejection sampling in order to reach a target acceptance rate. For a more detailed description of the adaptive MCMC method see Baker (2014) and Andrieu and Thoms (2008).

where y_t is the vector of k dependent variables, f_t the unobserved factors, and x_t the exogenous variables. The simplified model[32] without the exogenous parts x_t and w_t is:

$$y_t = Af_t + u_t \tag{9}$$

$$f_t = D(L)f_{t-1} + \varepsilon_t \tag{10}$$

Figure 3.1: Uncertainty proxy



Panagiotidis and Printzis (2019) use a set of 9 economic indicators from 1994M01 to 2015M08 to estimate the model. The variables, their sources and the transformations are presented in Table 3.1. An illustration of the unobserved factor is presented in Figure 3.1 annotated with the most important events of recent years. There is a clear match with the main economic events of the country.

[32] The model is estimated by maximum likelihood (ML) in a state-space form and using the Kalman filter. Several information criteria are applied to determine the number of dynamic factors: Bai and Ng (2002), Bai and Ng (2007), Hallin and Liska (2007), Onatski (2009), Barigozzi et al. (2016), Guo-Fitoussi (2013), Hallin and Liska (2007) and Onatski (2009). Results suggest the use of one factor and they are presented in Panagiotidis and Printzis (2019).

Table 3.1: Macroeconomic variables and indices

	Variable	Abbreviation	Source	Transformation
Greek specific variables	Athens Stock Exchange closing prices	ASE	Athens Stock Exchange	(1− L)ln(Xt)
	Long-term Government Bond Yields	BONDS	Bank of Greece	(1− L)ln(Xt)
	Economic Sentiment Indicator	ESI	European Commission	(1− L)ln(Xt)
	Unemployment Rate	UNEMPL	Eurostat	(1− L)Xt
	Bank Interest Rate (Bank interest rates on new euro-denominated deposits and loans)	INTR	Bank of Greece	(1− L)ln(Xt)
	Industry Production Index (Total industry excluding construction)	IP	OECD	(1− L)ln(Xt)
	Loans to domestic private sector (Growth rate same period previous year)	LOANS	Bank of Greece	(1− L)Xt
Europe specific variables	Euro Area Business Climate Indicator	BCI	European Commission	Xt
	Economic Policy Uncertainty	EPU	Baker et al. (2015)*	Xt

Notes: *Xt* is the transformed variable and *L* is the lag-operator
*Data available on http://www.policyuncertainty.com/
The Economic Sentiment Indicator (ESI) and the Business Climate Indicator (BCI) are survey based indices conducted by the Directorate General for Economic and Financial Affairs (DG ECFIN). In Greece, the surveys are conducted by the Foundation of Economic & Industrial Research (FEIR/IOBE). See also (Panagiotidis and Printzis (2019)).

3.4.2 Firm-level Panel Data

We use an unbalanced panel of the 25000 larger Greek firms (turnover > 100000€) from 2000 to 2014. The annual balance sheets were obtained from the Infobank Hellastat database (IBHS)[33] and cover the main economic sectors of the Greek economy (see Table 3.2).

Table 3.2: Sectors of economic activity in Greece

Section	Sectors Description	Abbreviation
A	Agriculture, Animal Husbandry, Hunting and Forestry	Agriculture
B	Fishing	Fishing
C	Mining and Quarrying	Mining
D	Manufacturing	Manufacturing
F	Construction	Construction
G	Wholesale and Retail Trade; Repair of Motor Vehicles, Motorcycles and Personal and Household Goods	Trade
H	Hotels and Restaurants	Hotels
I	Transport, Storage and Communication	Transport
K*	Real Estate*	Real Estate

Notes: *The Real Estate sector of section K refers to division 70 without renting and business activities. The sectors of Public administration and defense; compulsory social security, Activities of households, Extra-territorial organizations and bodies, Electricity – Gas – Water supply, Financial Intermediation, Education, Health and Other Community, Social and Personal Service Activities (Sections L, P, Q, E, J, M, N, O respectively) are excluded in this study. For more details on this see http://www.cbfa.gr/

[33] See http://www.cbfa.gr/ .The sample follows the national statistical classification of economic activities, (STAKOD–03) which is derived from the corresponding classifications of European Union (NACE Rev. 1.1) and United Nations (ISIC 3.1)

We construct the following variables: Investment (*I*) is the capital expenditures in material fixed assets, equal to the change of the net value of fixed assets plus the year depreciation, capital stock (*K*) is the book value of total fixed assets, cash flow (*CF*) are the net profits plus depreciation, growth of sales (*GS*) is the change in sales S (annual turnover), idiosyncratic Uncertainty (id_{it}) is proxied by the standard deviation of scaled sales estimated in a 5-year rolling window and uncertainty (h_t) is the common unobserved factor as estimated by the dynamic factor model. Data are trimmed at the 5th and 95th percentile to eliminate potential outliers. Firms with missing observations were not included in the sample. Descriptive statistics are presented in Table 3.3 and

Table *3.4*.

Table 3.3: Descriptive Statistics

Variable	mean	sd	p5	p25	p50	p75	p95
I/K	0.16772	0.24602	-0.09333	0.00669	0.08052	0.27394	0.70908
CF/K	0.54804	1.06270	-0.21371	0.05094	0.18407	0.55359	2.88735
GS/K	-0.10782	2.67019	-4.68852	-0.39371	0.00196	0.37024	3.96232
id_{it}	7.02104	14.82456	0.05912	0.29597	1.17431	5.62592	38.05542
h_t	0.34285	2.12800	-2.37267	-1.67847	0.19047	1.94258	4.65384

Notes: Investment (I): Capital Expenditures in material fixed assets,
Capital Stock (K): The lagged book value of total assets,
Cash Flow (CF): Net profits plus depreciation,
Growth of Sales (GS): Change is the annual turnover,
Idiosyncratic Uncertainty (id_{it}): Standard deviation of scaled sales estimated in a 5-year rolling window,
Economic Uncertainty (h_t): The common unobserved factor,
sd is the standard deviation and p5-p95 are the percentiles of the variables. The variables are trimmed at the 5st and 95th percentile to reduce the effect of outliers.

Table 3.4: Sectors' Descriptive Statistics

Variable	Agriculture		Fishing		Mining		Manufacturing		Trade	
	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd
I/K	0.134	0.186	0.139	0.180	0.137	0.216	0.145	0.188	0.172	0.261
CF/K	0.155	0.195	0.201	0.276	0.294	0.369	0.260	0.332	0.853	1.588
GS/K	0.083	0.679	0.140	1.047	0.004	0.879	-0.024	0.881	-0.338	4.932
id_{it}	1.144	1.977	1.677	2.126	1.411	2.328	1.931	3.301	13.225	24.251
h_t	0.343	2.128	0.343	2.128	0.343	2.128	0.343	2.128	0.343	2.128

Variable	Hotels		Transport		Construction		Real Estate	
	mean	sd	mean	sd	mean	sd	mean	sd
I/K	0.126	0.172	0.179	0.293	0.161	0.262	0.145	0.247
CF/K	0.098	0.119	0.868	1.859	0.584	1.137	0.556	1.477
GS/K	-0.006	0.127	0.051	6.046	-0.171	4.293	-0.147	2.516
id_{it}	0.274	0.520	19.000	42.704	9.848	22.475	5.877	14.927
h_t	0.343	2.128	0.343	2.128	0.343	2.128	0.343	2.128

3.5 Results

We perform quantile regression analysis at 3 different levels: (i) Aggregate level, (ii)firm size level, and (iii) sectoral level. At the aggregate level, we use the entire dataset. At the firm size level, we classify the sample into three categories: small, medium and large firms. At the sectoral level, we focus on each sector of the Greek economy.

3.5.1 Aggregate level

The results for the entire sample are reported in Table 3.5 and Figure 3.2. The Arellano-Bond estimation results are also reported (dash line). The impact of uncertainty on the investment ratio is negative and statistically significant. However, it varies substantially across quantiles of the outcome distribution. This provides evidence of a considerable heterogeneity effect. Firms with higher investment ratio are more sensitive to uncertainty changes compared with the less aggressive firms, in terms of investment.[34] Firms with relatively higher investment rate are more exposed to volatility fluctuations. The contribution of the idiosyncratic ($id_{i,t-1}$) term changes sign above the 25th quantile, from negative to positive. This implies that the investment performance of the relatively stronger investors is stimulated by an increasing variability of sales which seems to be a rather contradictory result. However, for the more aggressive firms, this could activate a growth option mechanism. The sign of the *GS* ratio is positive and in line with the theoretical findings. The impact of the cash flow coefficient is positive, statistically significant and implies the existence of financial constraints. Fazzari et al. (1988) and many subsequent empirical papers support the view that positive and high cash flow sensitivities belong to financially constrained firms that prefer internal financing or find it hard or costly to access external capital. In our case, this stands particularly for the firms that belong to the upper quantiles of the conditional distribution. The persistence characteristic of investment known as lagged investment effect is confirmed by the findings. It is positive and indicates that past behavior affects the firm's future decisions. The effect gets stronger across quantiles. Firms that invest aggressively exhibit more persistent investment

[34] This could be coming from various channels but future research on this would be of interest.

behavior. On the other hand, the persistence effect is weaker for the firms that belong to the lower quantiles.

Figure 3.2: Full Sample

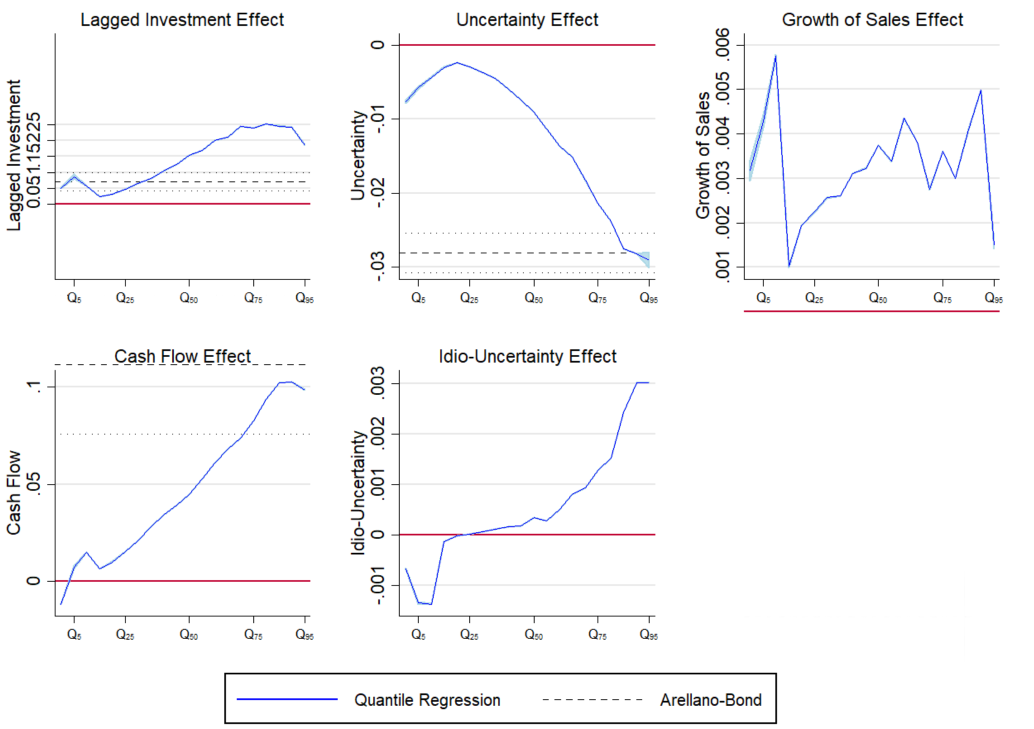


Table 3.5: Quantile Regression – Full sample

Variable	q1	q5	q10	q15	q20	q25	q30	q35	q40	q45
$(I/K)_{i.t-1}$	0.0509***	0.0872***	0.0574***	0.0249***	0.0317***	0.0460***	0.0645***	0.0809***	0.1035***	0.1258***
	(0.0007)	(0.0034)	(0.0001)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
$(CF/K)_{i.t-1}$	-0.0119***	0.0071***	0.0147***	0.0064***	0.0099***	0.0152***	0.0209***	0.0281***	0.0342***	0.0393***
	(0.0001)	(0.0005)	(0.0000)	(0.0000)	(0.0000)	(0.0001)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
$(GS/K)_{i.t-1}$	0.0032***	0.0043***	0.0058***	0.0010***	0.0019***	0.0022***	0.0026***	0.0026***	0.0031***	0.0032***
	(0.0001)	(0.0001)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
h_{t-1}	-0.0076***	-0.0058***	-0.0043***	-0.0030***	-0.0024***	-0.0029***	-0.0038***	-0.0045***	-0.0059***	-0.0074***
	(0.0001)	(0.0001)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
$id_{i.t-1}$	-0.0007***	-0.0014***	-0.0014***	-0.0001***	-0.0000***	0.0000***	0.0001***	0.0001***	0.0002***	0.0002***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)

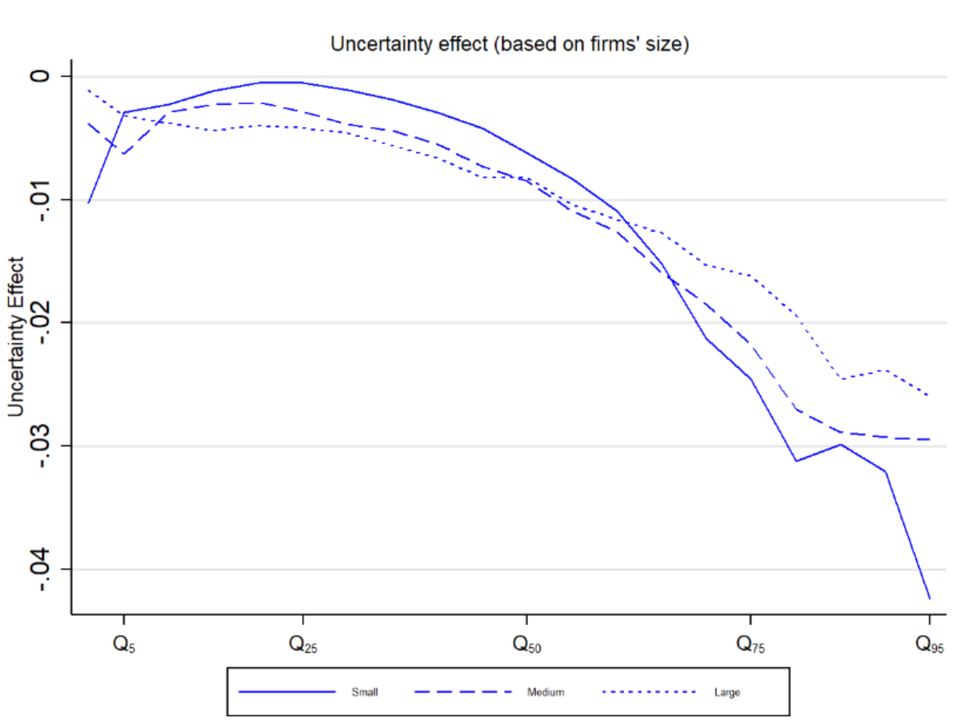
Variable	q50	q55	q60	q65	q70	q75	q80	q85	q90	q95
$(I/K)_{i.t-1}$	0.1539***	0.1696***	0.2009***	0.2106***	0.2443***	0.2391***	0.2533***	0.2458***	0.2422***	0.1858***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0001)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0006)
$(CF/K)_{i.t-1}$	0.0448***	0.0527***	0.0607***	0.0679***	0.0738***	0.0826***	0.0935***	0.1022***	0.1028***	0.0986***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0001)	(0.0000)	(0.0001)
$(GS/K)_{i.t-1}$	0.0037***	0.0034***	0.0043***	0.0038***	0.0028***	0.0036***	0.0030***	0.0041***	0.0050***	0.0015***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
h_{t-1}	-0.0091***	-0.0113***	-0.0137***	-0.0152***	-0.0183***	-0.0214***	-0.0238***	-0.0275***	-0.0282***	-0.0290***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0006)
$id_{i.t-1}$	0.0003***	0.0003***	0.0005***	0.0008***	0.0009***	0.0013***	0.0015***	0.0024***	0.0030***	0.0030***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Observations	91255	91255	91255	91255	91255	91255	91255	91255	91255	91255
Firms	18266	18266	18266	18266	18266	18266	18266	18266	18266	18266

Notes: The model is estimated using a two-step GMM method developed by Powell (2014) and implemented in STATA 14. The estimation is based on the Markov Chain Monte Carlo (MCMC) optimization method. Robust standard errors are reported in braces. The h term is the measure of economic uncertainty. while the id term refers to the idiosyncratic uncertainty. Current values of h_{t-1} and one-period lagged values for the rest of the regressors are used as instruments. To eliminate the effect of outliers the data are screened by trimming observations at the 5st and 95th percentile.
* significant at the 5% level; ** significant at the 1% level; *** significant at the 0.1% level

At the second level of analysis, we classified the total sample in three categories of small, medium and large sized firms based on the annual turnover percentile ranking. The results are presented in Table 3.7 in the Appendix. Figure 3.3 summarizes the uncertainty effects for the three categories. The negative impact of uncertainty is more profound for the smaller firms that invest more, thus they seem to be more exposed. In contrast, small firms with lower investment rates are less affected and for certain quantile, the negative impact of uncertainty is near zero. For the large firms, the uncertainty effect also changes across quantiles. Relative larger firms with higher investment are affected less. On the other hand, large firms with lower investment rates, that is to say, they belong to the lower quantiles, are affected more.

To summarize, uncertainty is carrying the expected negative sign, an investment lag effect exists, the control variable of lagged cash flow to total assets indicates the presence of financial constraints and the sign of lagged growth of sales to total assets is consistent with the literature and the theory. The uncertainty effect is greater for the more aggressive firms in terms of the investment rate and firms behave differently in an uncertain environment depending on their size.

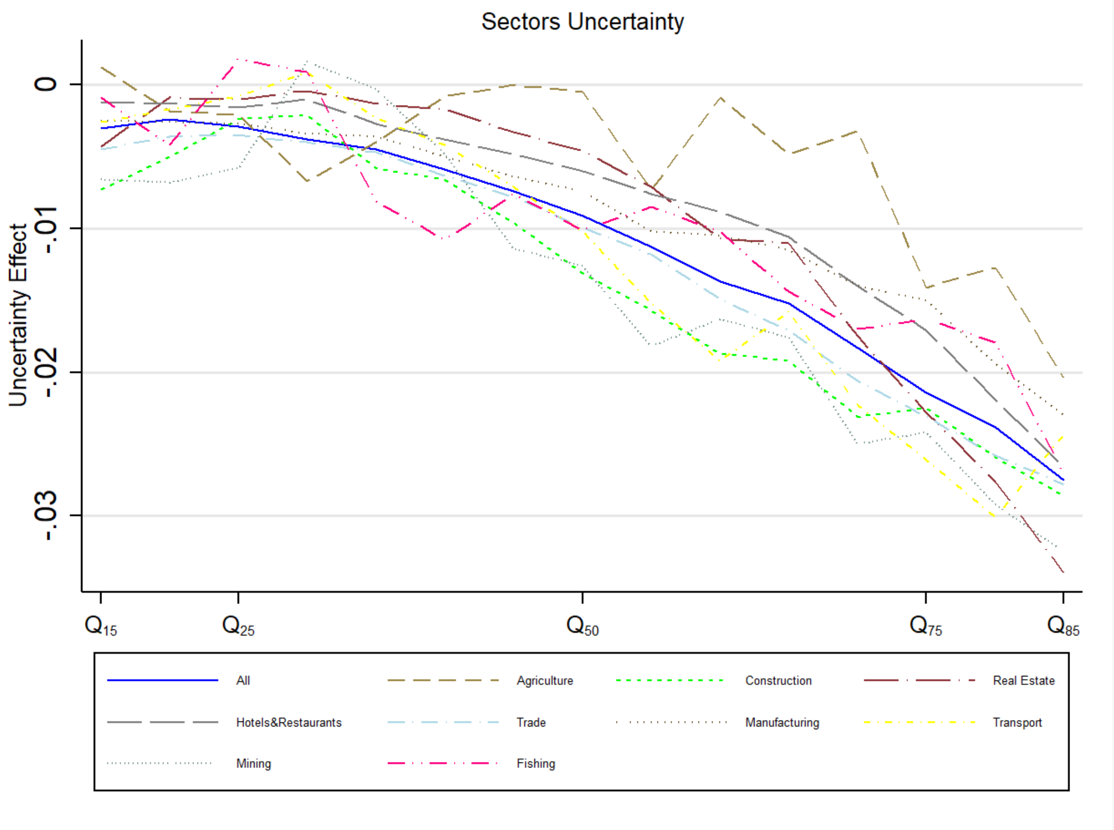
Figure 3.3: The effect of uncertainty on small, medium and large firms



3.5.2 Sector level

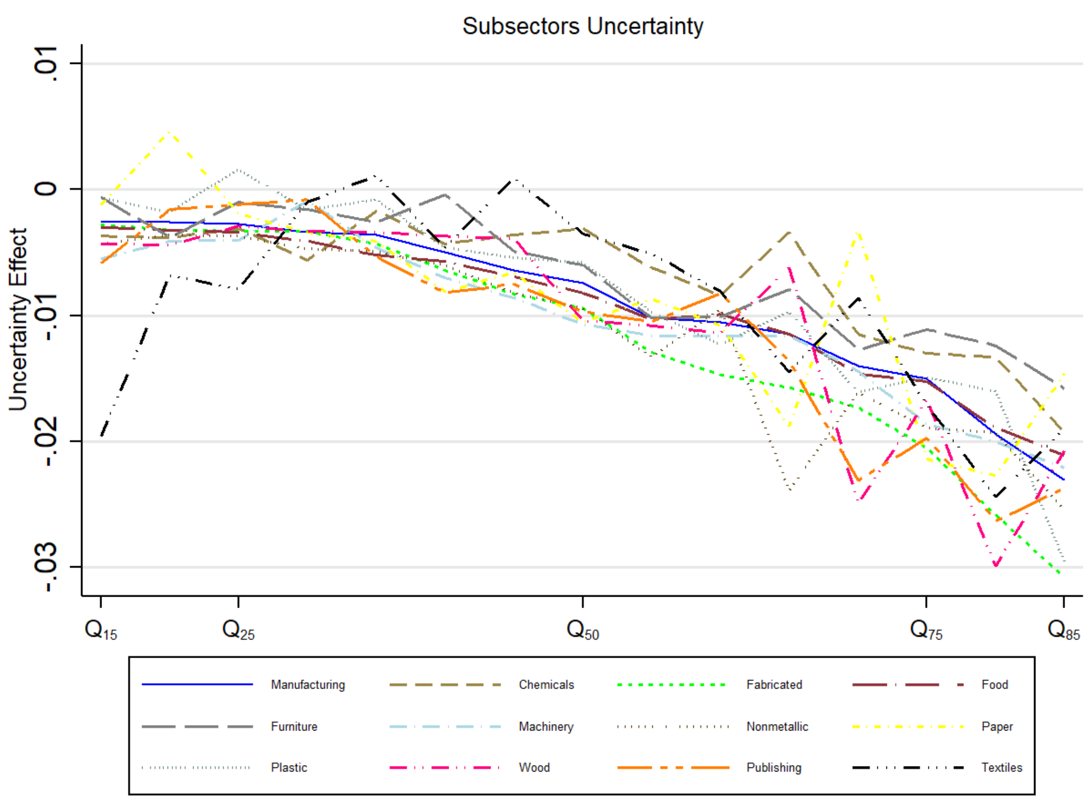
The empirical model of equation 5 is applied to each of the sectors of economic activity in the case of Greece. The results of the quantile regressions are presented in Tables 3.8-3.10 (Appendix). We focus on the effect of uncertainty. We summarize the regressions results in the combined graph presented at Figure 3.4. The uncertainty coefficient sign is negative for all sectors but the magnitude varies across and within sectors. For the first quantiles of the samples, the effects seem similar. More substantial differences appear above the median. In this case, the negative impact is found to be stronger on the Transportation sector, the Construction sector and the Mining sector. The effect is much smaller for the Agriculture and Hotels & Restaurants sectors. For the upper quantiles zone, firms in the Real Estate sector face also great investment losses. All in all, at the sector level there is a heterogeneous investment effect under uncertainty. For several sectors, the negative effect takes values below the average while for several others the impact is much stronger. Across quantiles the heterogeneity increases. The coefficient values vary from close to zero to 0.323 for the 85th quantile of the Real Estate sector.

Figure 3.4: The effect of uncertainty for Sectors



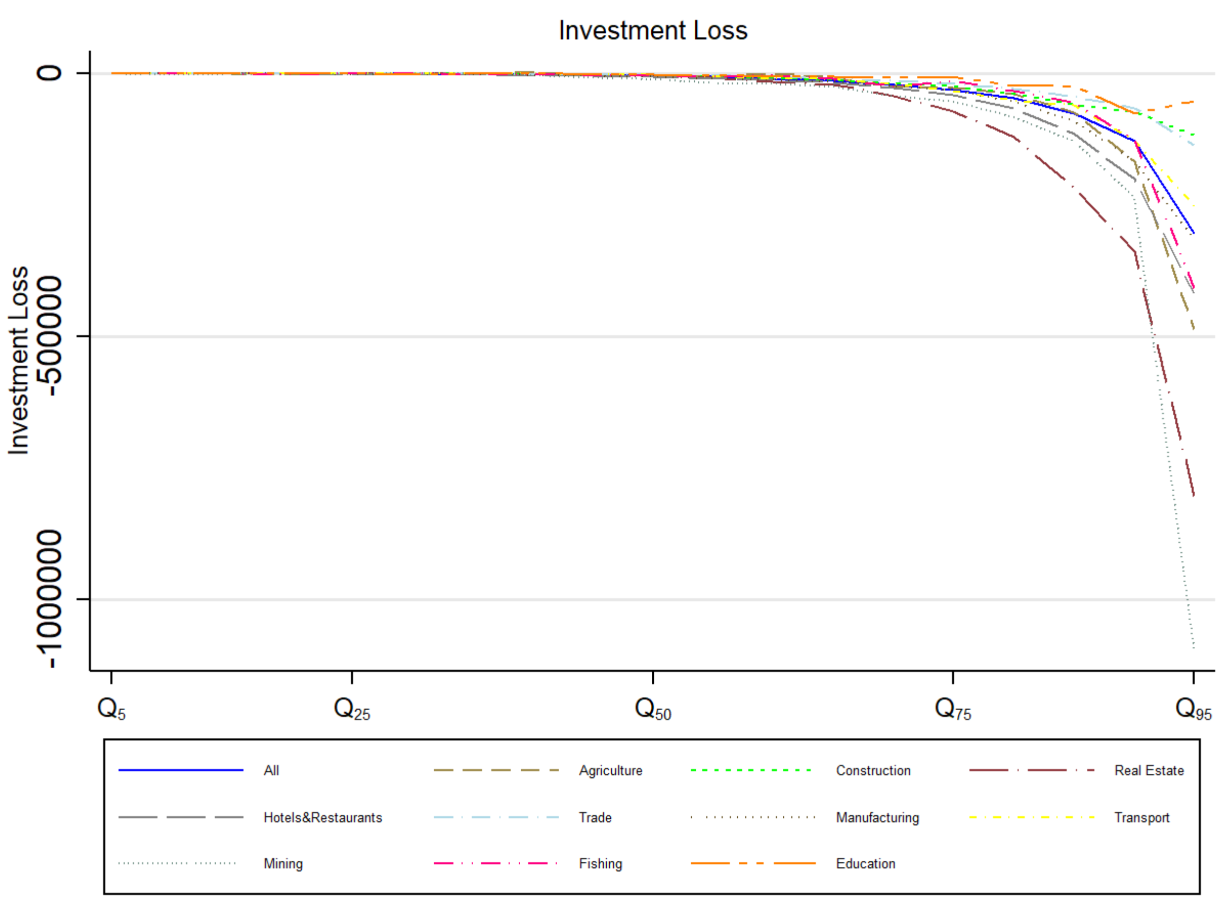
To dig a bit deeper, we perform a disaggregate analysis of the manufacturing sector focusing on the two-digit SIC subsectors. Tables 3.11-3.17 present the results and Figure 3.5 plots the uncertainty effect per quantile and subsector. Heterogeneity among subsectors is directly observable, especially in the upper quantiles zone. The effect of uncertainty is increasing along the quantiles and each subsector responds differently across quantiles.

Figure 3.5: The effect of uncertainty for Manufacturing two-digit Subsectors (NACE Rev. 1.1 & ISIC 3.1)



To provide a more tangible interpretation of the sectoral results, we gauge the impact of uncertainty by calculating the investment loss. The investment loss is defined as the marginal effect of uncertainty on investment rate, ceteris paribus, multiplied by the value of the capital stock. The results for all the sectors are presented in Figure 3.6. Below the median, the investment loss is rather small. The behavior changes above q75 and turns to be explosive. For the Real Estate and the Mining sectors an increase of uncertainty by one unit makes the investment loss to reach or exceed the level of one million euro. The main finding is that in terms of absolute losses the effect follows an exponential path across quantiles. Firms that invest more and own more capital stock i.e. more fixed assets are affected more in absolute terms.

Figure 3.6: Investment Loss for different sectors



3.6 Robustness Analysis

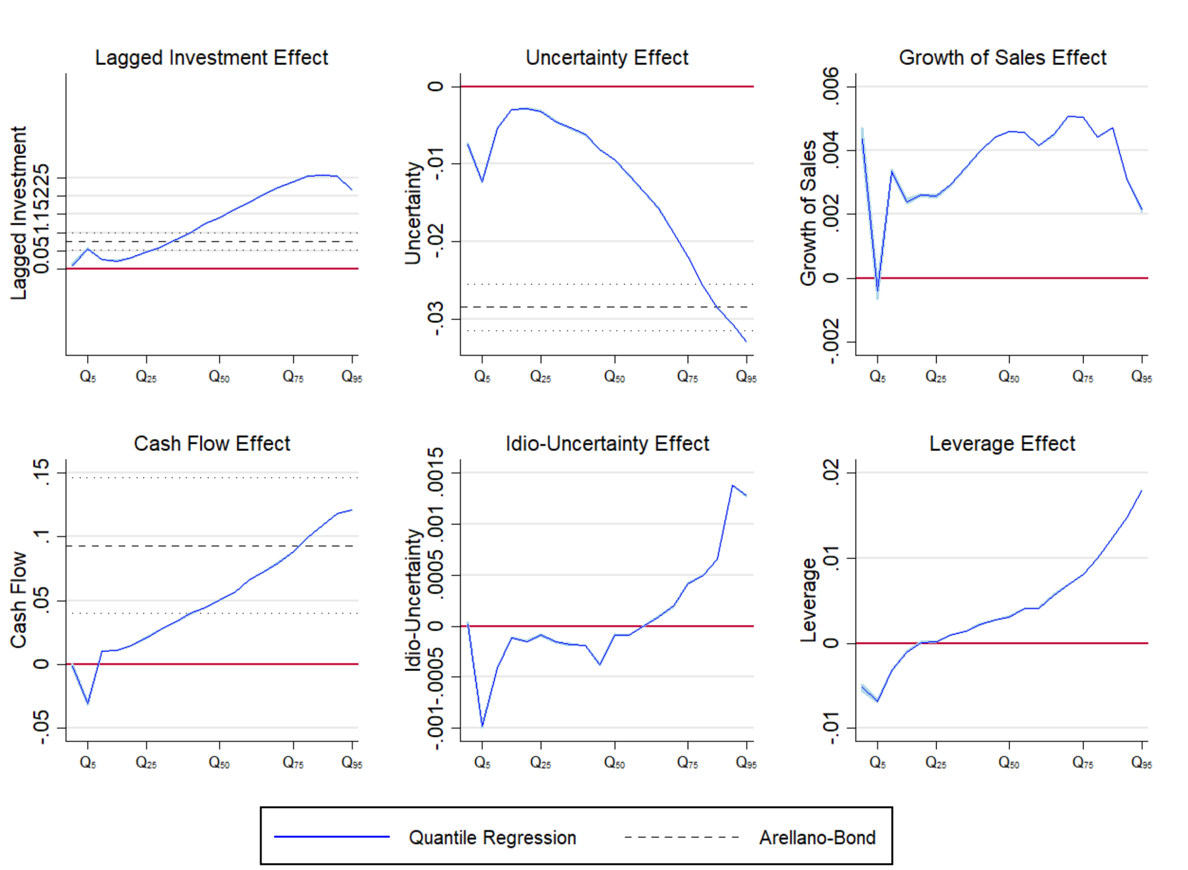
3.6.1 Robustness Checks

To check the robustness of our model, we consider an additional approach with the inclusion of the lagged leverage effect as a regressor. The new term is the lagged ratio $\left(\frac{D}{K}\right)_{it-1}$ where D is the total bank liabilities. The literature on the role of debt ratio provides mixed results depending on the firm's growth opportunities[35] or on the uncertainty regime (Baum et al., 2010). The augmented model is presented in Table 3.18 and in Figure 3.7. The model performs similarly to the original approach. There is no significant change in the behavior of the

[35] See Ahn et al. (2006) for a brief literature review on leverage and investment.

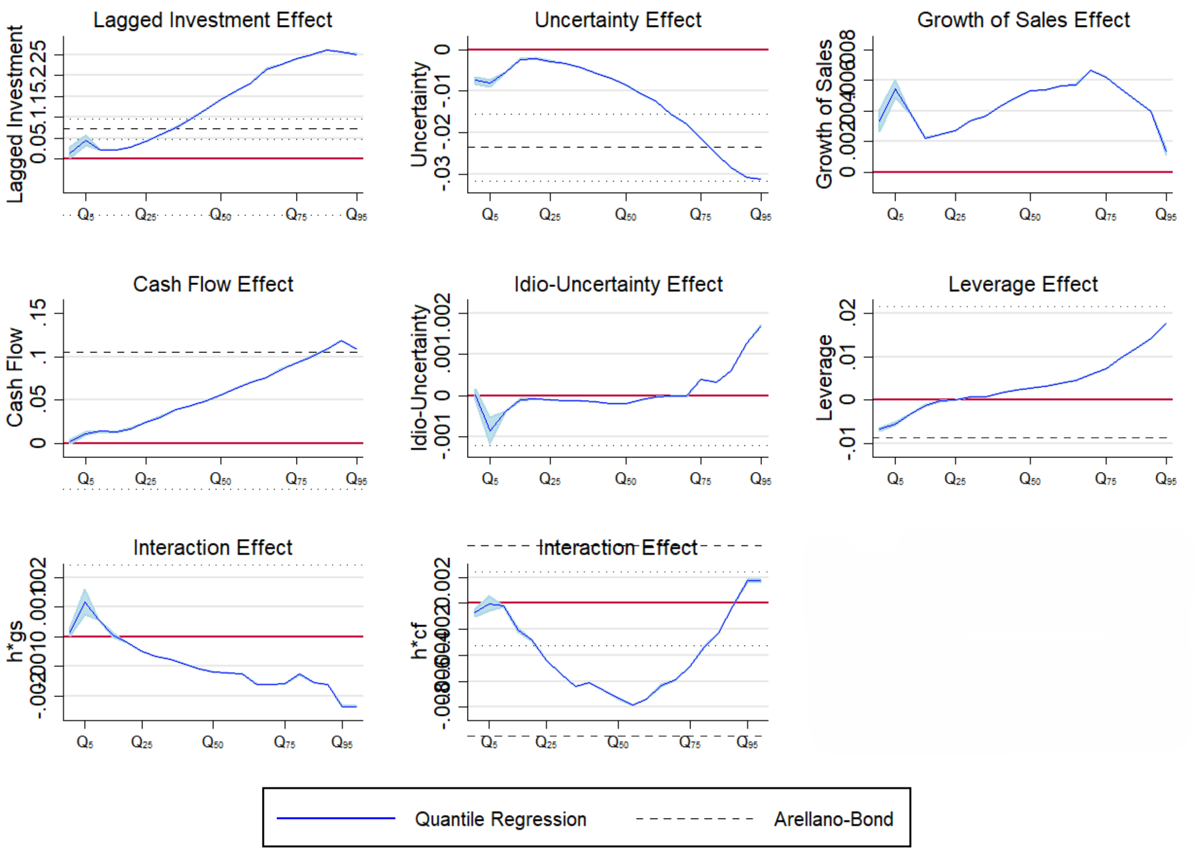
coefficients across quantiles and this provides more support to the robustness of our findings. The leverage term switches its sign above the 25th quantile. Thus, less aggressive firms face negative effects of leverage on investment and are constrained by increased debt. On the other hand, for firms that invest more than the median the effect is strongly positive. The findings suggest that investment in Greece is financially constrained and any rise in the leverage ratio can boost the investment performance.

Figure 3.7: Robustness Analysis – with Leverage Effect



We extend the original model by incorporating interaction terms between uncertainty, *GS* ratio and *CF* ratio. The aim is to examine the robustness of the model and to investigate the uncertainty effects on investment through alternative channels. The results are presented in Table 3.19 and Figure 3.8 and confirm the original specification. The transmission mechanism of the volatility effect through the alternative channels is mostly negative and the evolution of the coefficients across quantiles varies. There is a switch of the sign only in the lower quantiles of the *GS* interaction effect and in the higher quantiles of the *CF* interaction effect. The results indicate that the impact of *GS* ratio and *CF* ratio on investment is weakening under uncertainty. In other words, the investment response on *GS* and *CF* decreases in conditions of increased economic volatility. This result could be a sign of a "wait and see" effect, an indication of a precautionary behavior that makes firms to defer or to cancel projects and to prefer to wait. The literature of investment under uncertainty in a partial irreversibility framework suggests similar results.

Figure 3.8: Robustness Analysis – with Interaction Terms



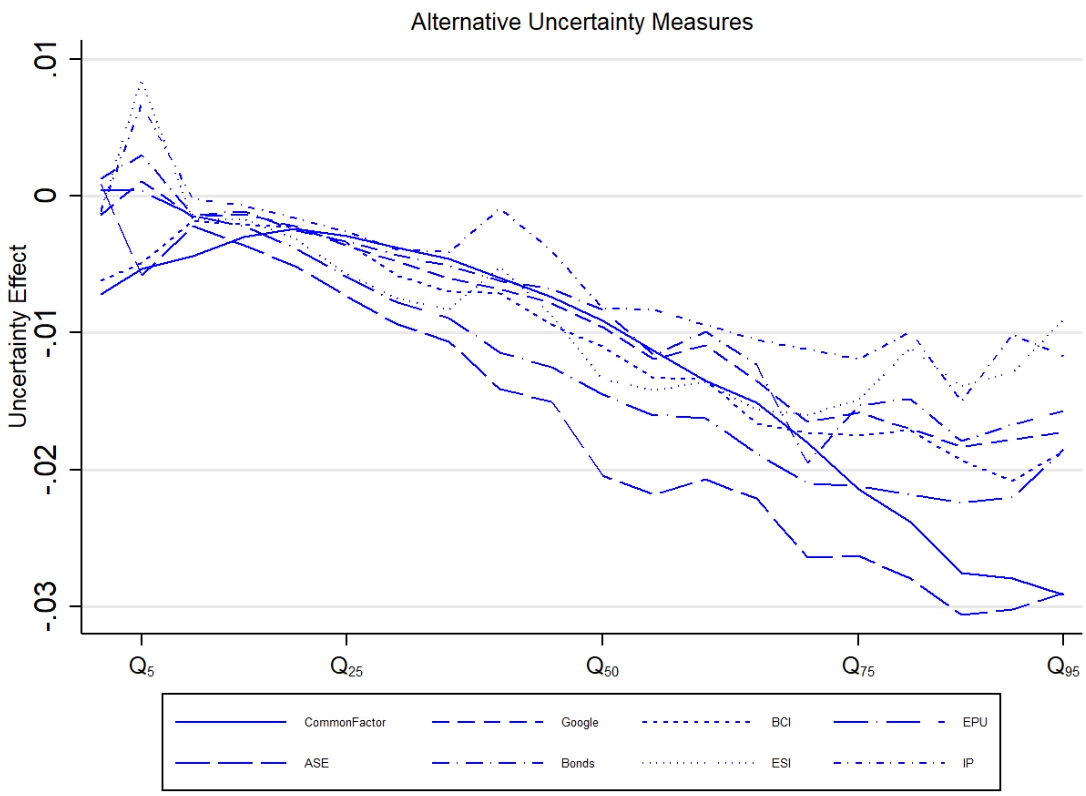
We further investigate the robustness of our results by using alternative measures of economic volatility. Individual proxies are used together with a Greek specific index of uncertainty $hgrexit_{t-1}$, based on the web search queries of the Google Trends online tool.[36] The quantile regression estimates of the uncertainty determinant are summarized in Figure 3.9. [37] The investment performance varies depending on each proxy and across quantile, a

[36] The key phrases are: Greek-Greece crisis, Greek debt crisis, Greece bailout, Greek debt, Grexit, Greece uncertainty.

[37] Coefficients estimates for each quantile regression are not reported but they are available upon request. Results once again support the robustness of the model.

quite expected result. In upper quantiles, the $hgrexit_{t-1}$ index underestimates the importance of the negative uncertainty effect. ASE index and EPU index overestimate it compared to the common unobserved factor measure. The last seems to capture the uncertainty effect of a more complex economic environment than this suggested by the individual volatility proxies.

Figure 3.9: Robustness Analysis – Alternative measures of Uncertainty



We complete the battery of robustness checks with a pooled quantile regression estimation at aggregate and sector level and a further approach based on the Machado and Santos Silva (2019) model. The results are summarized in Table 3.20 and Figures 3.10,3.11 & 3.12. The broad inferences of our main empirical model remain intact. The pooled quantile regression estimates are qualitatively similar. The restricted model of Machado and Santos Silva (2019) relies on very strong and restrictive assumptions regarding exogeneity and n/T ratio. The n/T ratio of our panel dataset is large and may lead to bias in the asymptotic distribution. The assumptions of strict exogeneity and no serial correlation do not hold for the lagged dependent variable as well as for the rest of the regressors. The statistical significance of the lagged investment effect and the growth of sales is low. However, for uncertainty and cash flow effects the key results are maintained, they are of the same magnitude and have the same sign.

Figure 3.10: Robustness Analysis – Pooled Quantile Regression

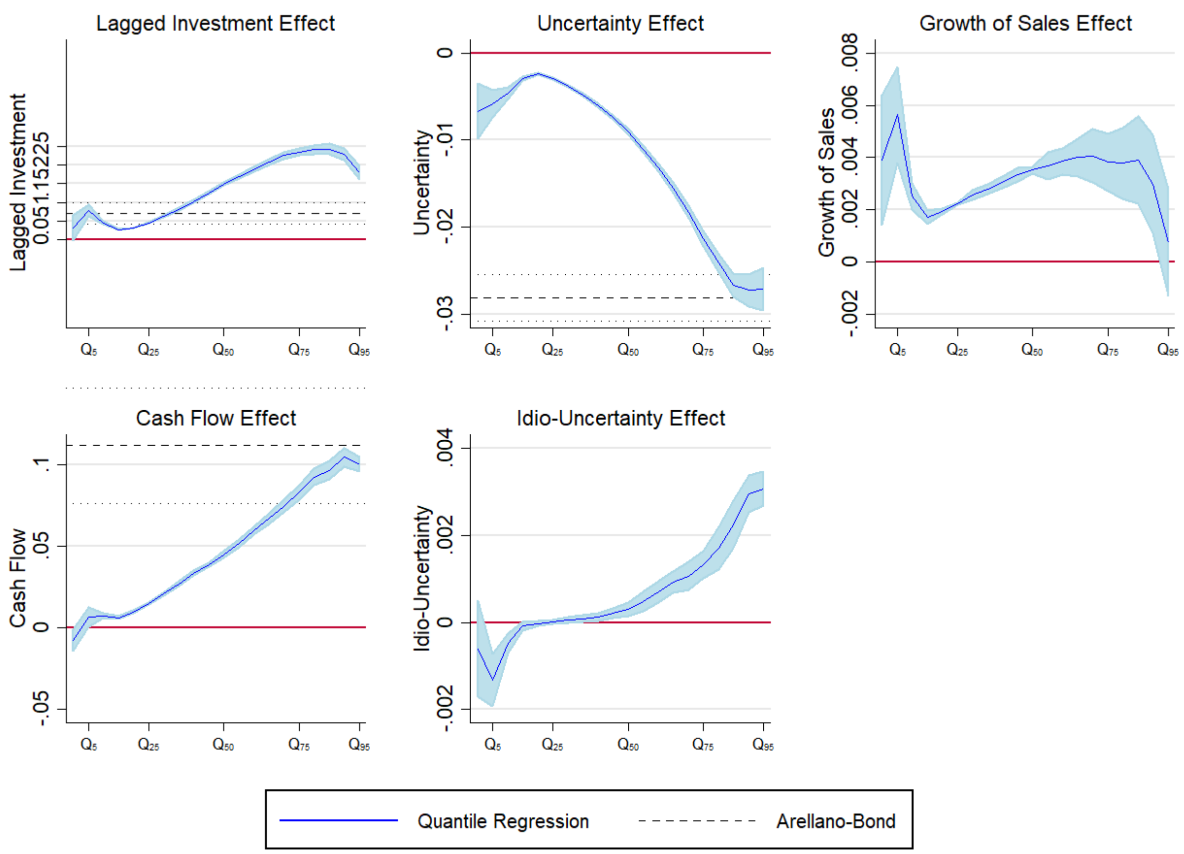


Figure 3.11: Robustness Analysis – The effect of Uncertainty at the Sectoral Level- Pooled Quantile Regression

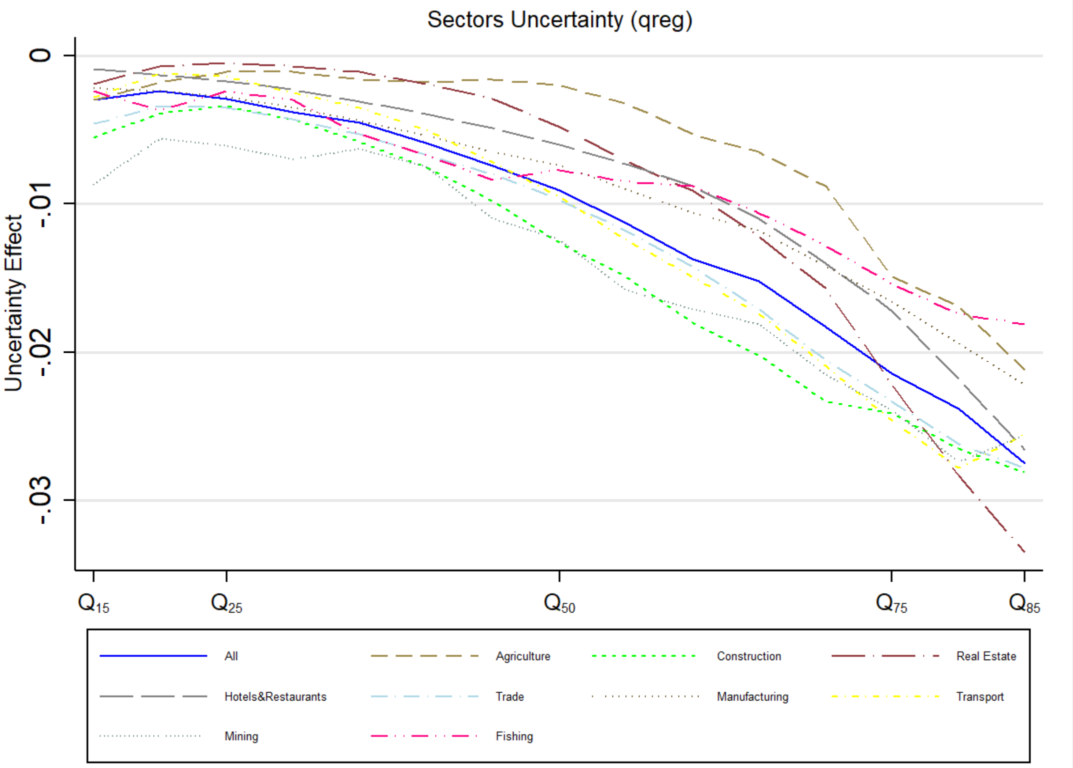
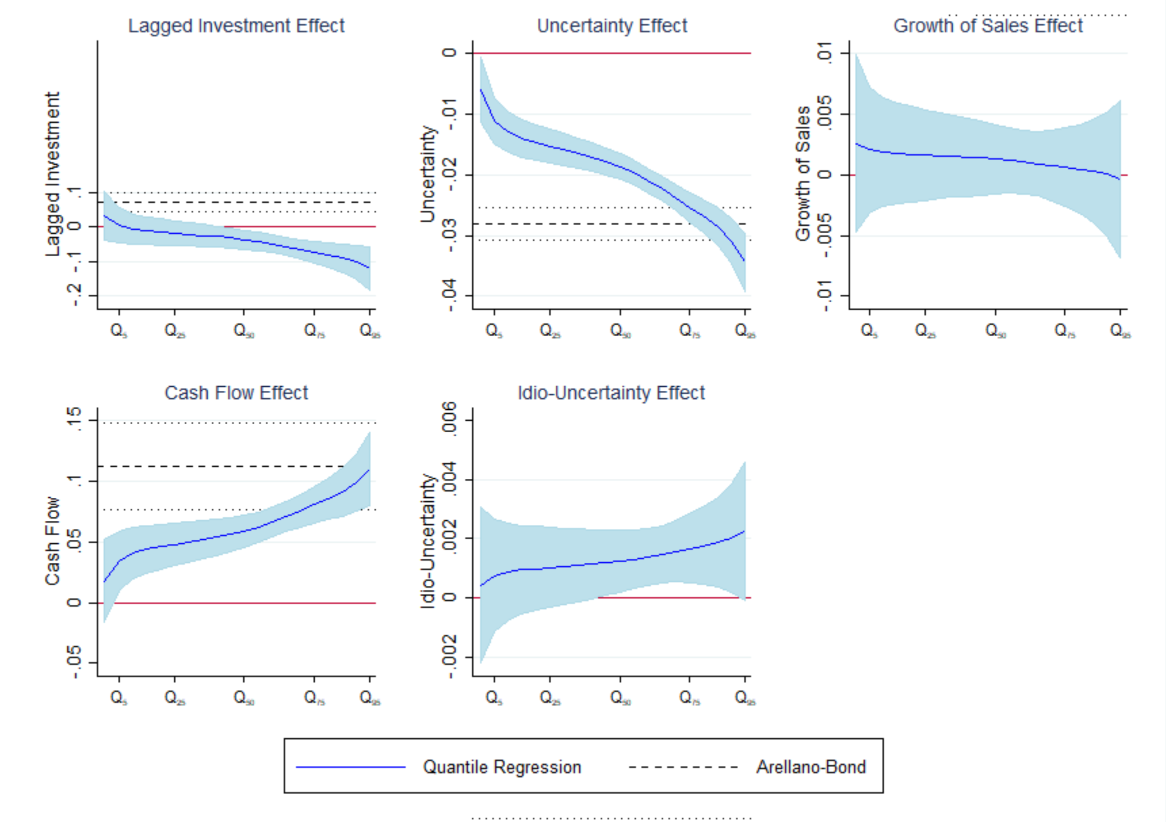


Figure 3.12: Robustness Analysis – Machado and Santos Silva (2019) quantile regression



3.6.2 Regression Clustering Method

The findings of the quantile regression approach suggest that the uncertainty effect varies across quantiles but also differs among firms of different sizes. We examine the heterogeneity in the slope parameters and check the robustness of the empirical results by applying the regression clustering method of Sarafidis and Weber (2015). The method is valid for short panel datasets. Without a priori information about the clusters' number, the method groups individuals into clusters with slope parameter homogeneity within clusters. The framework is based on a partitional clustering analysis using an information-based criterion. The approach is implemented in Stata using the xtregcluster command by Christodoulou and Sarafidis (2017). The method is computationally intensive, so we applied it on random subsamples to reduce the dimension of the data. The initial partition was obtained based first, on a predetermined classification of small and medium-sized enterprises (SMEs) as defined by the European Commission and second, following the national statistical classification of economic activities for the six largest sectors in Greece (Manufacturing, Trading, Hotels & Restaurants, Transports, Construction, Real Estate) . In addition we obtained the initial partition based on the explanatory variables' set by using the official Stata command cluster kmeans. Tables 3.21 - 3.22 in the Appendix present the regression results for the distinct clusters of each model. Figures 3.13 - 3.17 present the linear predictions graphs of the heterogeneous slopes and the cluster-specific plots for the uncertainty variable. Results indicate the existence of heterogeneous clusters in panel-data. Focusing on uncertainty heterogeneous effects are also apparent. The lack of homogeneity provides a clear justification for the selection of quantile regression as method of analysis. These results open up an interesting field of further research especially for approaches that take into account the quantile-regression-based clustering methods.

3.7 Conclusions

This paper examines investment under uncertainty in the case of Greece within a panel quantile estimation framework. The results suggest a negative impact of volatility on firm's investment decisions but its magnitude varies across quantiles. The effect of uncertainty on investment increases for firms with higher investments rate. We also rank firms based on their annual turnover and we find that smaller firms face the largest investment losses due to uncertainty. Next, a sectoral analysis is performed and a heterogeneity effect is revealed. The negative impact is found to be stronger on the following sectors: Transportation, Construction, Real Estate, and Mining sectors. A battery of different robustness checks is conducted and the results provide more support to the empirical findings of the model specification.

As far as policy makers are concerned, one could take into account the different responses across quantiles rather than just rely on the simplified approach of the conditional mean. Our results show that the size, the sector, and the investment rate quantile of each firm alter the impact of uncertainty on investment. Any recommendation to mitigate the negative effects or to recover stability will not have the same implications for all.

3.8 References

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3.9 Appendix

Table 3.6: Literature review

	Title	Authors	Data	Methodology	Conclusions
1	The Real and Financial Impact of Uncertainty Shocks	Alfaro et al. (2016)	Compustat data for stock returns and accounting variables covering the period 1963-2014 for USA.	The paper examines the effect of uncertainty shocks on firms' real and financial activity. A theoretical (dynamic capital structure model) and an empirical model (OLS and 2SLS) are applied.	The theoretical model shows that financial frictions amplify the impact of uncertainty shocks. The empirical regression models find that investment and employment are reduced by uncertainty shocks while cash holdings are increased.
2	The Effect of Policy Uncertainty on Investment Plans : Evidence from the Unexpected Acceptance of a Far-Reaching Referendum in Switzerland	Abberger et al. (2016)	Data from bi-annual KOF investment surveys (Autumn 2013-Spring 2014 for Switzerland). The survey captures several firms' characteristics including irreversibility of investment	An empirical model in a regression framework is used. Investment plans is the dependent variable regressed on expected demand, uncertainty, irreversibility and individual firm characteristics.	Increased policy uncertainty affects investment plans in a negatively. These effects are stronger in the case of irreversibility.
3	Short and Long Run Uncertainty	Barrero et al. (2016)	Compustat panel quarterly data from 1996Q2 to 2013Q1 and annual data for 1997-2013. Data include volatility measures, cash flow, sales, investment, Tobin's' q, capital, employees.	Implied volatilities are used to proxy short and long run uncertainty at a firm level. Regressions are applied to study empirically the relationship investment-uncertainty and hiring-uncertainty. They also examine the drivers of short and long run uncertainty. The results are interpreted by developing a theoretical model.	Uncertainty effect on investment and employment is negative. Investment is more responsive to long run uncertainty because of higher adjustment costs and lower depreciation rates of capital. The effect is stronger for *"smaller, slow-growing, and more highly-levered firm"*.
4	Political Uncertainty and Firm Investment: Project-Level Evidence from M&A Activity	Chen et al. (2017)	To measure political uncertainty gubernatorial and presidential election data from 1982 to 2013 for four USA states are used. Merger and acquisition data for the same period to proxy investment activity and project-level effects.	A difference-in-difference-in-difference model is estimated.	Political uncertainty alters investment projects announced in election years. The uncertainty effect depends on the investments' characteristics.
5	Uncertainty, Capital Investment, and Risk Management	Doshi et al. (2017)	Daily data for crude oil price and production from 1990 to 2003. Panel dataset for crude oil and gas firms in USA (capital investment, cash flow, size, leverage, sales)	The option-implied oil price volatility is used as price uncertainty measure. Panel regressions are estimated to examine the relationship between CAPEX, debt, hedging intensity and price uncertainty.	The effect of price uncertainty depends on the firm size. In periods of high uncertainty small (large) firms (do not) lower capital expenditure and debt issuance without (by) adjusting the hedging intensity.
6	Exports, Investment and Policy Uncertainty	Greenland et al. (2016)	Policy uncertainty is the index of Baker et al. (2015). Trade flows cover the period 1995-2013 for 15 countries. Macroeconomic variables include GDP, BCI, CCI, CLI (OECD).	A theoretical model is applied based on a Cobb Douglas utility function and incorporating the uncertainty factor. The empirical methodology is based on a gravity model.	The effect of policy uncertainty is detrimental for international trade. In periods or markets of increased policy uncertainty firms delay investment projects.
7	Investment under Uncertainty in Electricity Generation	Gugler and Liebensteiner (2016)	A panel dataset of 437 electricity generating firms over the annual period 2006–2014 (variables: investment, capacity,	The hours running serves as a firm specific measure of uncertainty. The variance of wholesale electricity prices is used as proxy for industry-wide uncertainty. An empirical regression model based on	Firms' investment activity is triggered by aggregate uncertainty and decreased by firm specific uncertainty.

	Title	Authors	Data	Methodology	Conclusions
			profits, spot price, hours running.).	a Tobin's q investment model is used. Regressions are run for different aggregation levels.	
8	On measuring uncertainty and its impact on investment: cross-country evidence from the euro area	Meinen and Röhe (2016)	Macroeconomic data from 1996 to 2015 for shadow short rate, index of consumer prices, industrial production, unemployment	Four uncertainty indicators are compared: The volatility of stock market returns, EPU index, dispersion of production expectations from surveys and the unpredictable components of a set of macroeconomic indicators. Three different VAR models are used to estimate the response of investment to uncertainty shocks.	The response of investment to uncertainty shocks is negative. Authors state that "….uncertainty can account for a relevant portion of the decrease in gross fixed capital formation in machinery and equipment in the course of the Great Recession."
9	Business uncertainty and investment: Evidence from Japanese companies	Morikawa (2016)	Quarterly forecast survey data from 2004 to 2014.	Four uncertainty measures are calculated: forecast dispersion, forecast error dispersion, mean absolute forecast error and an aggregated diffusion index. OLS regressions are applied to estimate the investment response to uncertainty controlling for different business conditions.	Business uncertainty increases in the years of crisis, Small and manufacturing companies face higher uncertainty compared to small and non-manufacturing firms. The relationship between uncertainty and investment is negative.
10	Political uncertainty and corporate investment: State-level evidence from Australia	Narayan et al. (2017)	A panel of 1331 Australian firms is examined. Data include capital expenditure, assets, cash, leverage, sales, age for the period 2000-2015.	Preferential voting and parliamentary seat share data are used to proxy uncertainty together with various measures of politival turnover. A standard and an augmented investment model (q-model) are employed to examine the investment performance.	Political uncertainty affects corporate investment in heterogeneous way. State elections do not affect corporate investment. The strongest political parties influence investment more.
11	Measuring Global and Country-Specific Uncertainty	Ozturk et al. (2017)	Forecast data from Consensus Forecasts over 1989-2014 period covering 45 countries are used to compute uncertainty proxy.	Based on CAPM methodology they authors decompose uncertainty into common and idiosyncratic (based on forecast errors).	The effect of idiosyncratic uncertainty on real activity is negligible. The effect of common uncertainty is negative, strong and persistent.
12	Firms' investment decisions – explaining the role of uncertainty	Rashid and Saeed (2017)	Firm-level data over 1988-2013 for Pakistan. Data include sales, CPI, IP, investment, debt.	First a theoretical model is proposed based on the value optimization problem. The empirical estimation is made by a GMM-model. Firm specific uncertainty is calculated by an autoregressive model of firm sales. An ARCH model for CPI and IP is used to proxy aggregate uncertainty.	Uncertainty increase curtails investment spending. The effect of aggregate uncertainty is stronger compared to that of idiosyncratic uncertainty.
13	Corporate investment decisions under political uncertainty	Riem (2016)	Panel data for German manufacturing firms over 1994-2012, (survey and balance sheet data for investment, sales, cash flow), election data and macroeconomic data.	A neoclassical investment model augmented with the presence of state election and federal election uncertainty is used. The model is estimated with OLS.	State elections (uncertainty) decrease investment ratios by 10.5%. Electoral uncertainty has a negative impact on irreversible investments.

	Title	Authors	Data	Methodology	Conclusions
14	Policy Uncertainty and Manufacturing Investment: Evidence from U.S. State Elections	Shelton and Falk (2016)	Annual panel of Us states over 1968-2004 period. Data include vote shares, governor turnover, polarizations, investment, output, GDP, unemployment	Electoral uncertainty is measured based on the natural log of the vote margin, where vote margin is the difference between the two first parties. Investment is regressed on policy uncertainty and several control variables.	There is a 2.7% fall in investment when electoral uncertainty doubles. State-level policy uncertainty drives investment to neighbouring states rather than postponing investment projects.
15	Industrial Characteristics and the Investment – Uncertainty Relationship : A Panel Study of Data on Japanese Firms	Tanaka (2016)	Panel data on Japanese firms from 1977 to 2012(investment, capital stock, cash flow, Tobin's q, land stock)	Four alternative measures of uncertainty are examined based on the real sales of the firm: Forecasting Error of Future Prediction by Autoregressive Model, Standard Error of the Autoregressive Model , Conditional standard deviation of the real sales growth rate of the three and of the five previous years. A basic investment Tobin's q model is employed.	The negative effect of uncertainty on investment is greater in case of low market competition, thus competition mitigates the uncertainty impact. Higher degree of irreversibility of investment increased the negative effect of uncertainty.
16	Strategic Growth Option , Uncertainty , and R & D Investment	Vo and Le (2017)	Data are collected form the Center for Research in Security Prices (CRSP) and from Compustat from 1985 to 2013 (investment, stock returns)	Uncertainty is the annual idiosyncratic volatility measured by the standard deviation of the residuals from regression of stock returns on market returns. A Tobin's Q model is used to examine the performance of the ratio of R&D expenditures to total assets.	When uncertainty is higher R&D investment is stimulated. The effect is more pronounced for small and young firms and for firms in more competitive industries. The results provide evidence of preemptive effect and strategic growth option.
17	Uncertainty, Incentive and Over/Under-Investment	Zhang (2017)	Data of listed companies in Shanghai and Shenzhen over 2007 – 2013 period.(dataset include investment, cash holdings, sales, fixed assets, stock returns, sales cost, profit, company size, etc)	Environmental uncertainty is calculated similar to Shen and Yu (2012). The level of inefficient investment is calculated by the use of the Richardson model. In the final empirical model inefficient investment is the dependent variable and the independent variable set includes environmental uncertainty, executive holdings (equity incentive) and other control variables.	Environmental uncertainty has a positive impact by reducing excessive investment and improving investment efficiency.

Table 3.7: Quantile Regression – Classification

	Variable	q10	q20	q30	q40	q50	q60	q70	q80	q90
Small Firms (p≤25)	$(I/K)_{i.t-1}$	0.0444***	0.0063***	0.0130***	0.0272***	0.0463***	0.0632***	0.0919***	0.0953***	0.0010***
		(0.0004)	(0.0005)	(0.0001)	(0.0001)	(0.0000)	(0.0000)	(0.0000)	(0.0002)	(0.0001)
	$(CF/K)_{i.t-1}$	0.0071***	-0.0004***	0.0011***	0.0054***	0.0134***	0.0221***	0.0342***	0.0346***	0.0791***
		(0.0013)	(0.0001)	(0.0000)	(0.0001)	(0.0000)	(0.0000)	(0.0000)	(0.0001)	(0.0000)
	$(GS/K)_{i.t-1}$	-0.0004	0.0001***	0.0003***	-0.0001***	-0.0003***	-0.0039***	-0.0069***	-0.0084***	0.0033***
		(0.0008)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
	h_{t-1}	-0.0023***	-0.0005***	-0.0011***	-0.0029***	-0.0062***	-0.0109***	-0.0213***	-0.0312***	-0.0321***
		(0.0001)	(0.0001)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
	$id_{i.t-1}$	-0.0009***	-0.0002***	0.0000***	0.0003***	0.0009***	0.0017***	0.0034***	0.0056***	0.0080***
		(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
	Observations	10291	10291	10291	10291	10291	10291	10291	10291	10291
	Firms	2931	2931	2931	2931	2931	2931	2931	2931	2931
	Variable	q10	q20	q30	q40	q50	q60	q70	q80	q90
Medium Firms (25<p<75)	$(I/K)_{i.t-1}$	0.0580***	0.0205***	0.0490***	0.0742***	0.1135***	0.1447***	0.1606***	0.2177***	0.1918***
		(0.0022)	(0.0003)	(0.0000)	(0.0001)	(0.0001)	(0.0002)	(0.0005)	(0.0003)	(0.0000)
	$(CF/K)_{i.t-1}$	0.0111***	0.0115***	0.0242***	0.0355***	0.0478***	0.0604***	0.0779***	0.0960***	0.1070***
		(0.0002)	(0.0000)	(0.0000)	(0.0001)	(0.0000)	(0.0000)	(0.0001)	(0.0000)	(0.0000)
	$(GS/K)_{i.t-1}$	0.0004	0.0019***	0.0017***	0.0029***	0.0018***	0.0038***	0.0031***	0.0028***	0.0056***
		(0.0003)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0001)	(0.0000)	(0.0000)	(0.0000)
	h_{t-1}	-0.0029***	-0.0021***	-0.0039***	-0.0055***	-0.0085***	-0.0126***	-0.0185***	-0.0270***	-0.0293***
		(0.0001)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0001)	(0.0001)	(0.0000)	(0.0000)
	$id_{i.t-1}$	-0.0008***	0.0000***	-0.0000***	0.0003***	0.0001***	0.0012***	0.0021***	0.0025***	0.0046***
		(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
	Observations	27497	27497	27497	27497	27497	27497	27497	27497	27497
	Firms	7524	7524	7524	7524	7524	7524	7524	7524	7524
	Variable	q10	q20	q30	q40	q50	q60	q70	q80	q90
Large Firms (p≥75)	$(I/K)_{i.t-1}$	0.0666***	0.0832***	0.1408***	0.1919***	0.2907***	0.2878***	0.3291***	0.3574***	0.4087***
		(0.0021)	(0.0001)	(0.0002)	(0.0000)	(0.0006)	(0.0001)	(0.0000)	(0.0004)	(0.0001)
	$(CF/K)_{i.t-1}$	0.0152***	0.0146***	0.0253***	0.0369***	0.0439***	0.0581***	0.0698***	0.0842***	0.0964***
		(0.0009)	(0.0000)	(0.0001)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
	$(GS/K)_{i.t-1}$	0.0082***	0.0032***	0.0045***	0.0054***	0.0103***	0.0078***	0.0069***	0.0076***	0.0115***
		(0.0004)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
	h_{t-1}	-0.0038***	-0.0040***	-0.0046***	-0.0066***	-0.0082***	-0.0116***	-0.0153***	-0.0194***	-0.0238***
		(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
	$id_{i.t-1}$	-0.0020***	-0.0005***	-0.0003***	-0.0003***	0.0002***	-0.0002***	0.0000***	0.0003***	0.0011***
		(0.0001)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
	Observations	21175	21175	21175	21175	21175	21175	21175	21175	21175
	Firms	4556	4556	4556	4556	4556	4556	4556	4556	4556

Notes: The models are estimated using a two-step GMM method developed by Powell (2014) and implemented in STATA 14. The estimations are based on the Markov Chain Monte Carlo (MCMC) optimization method. Robust standard errors are reported in braces. The h term is the measure of economic uncertainty. while the id term refers to the idiosyncratic uncertainty. Current values of h_{t-1} and one-period lagged values for the rest of the regressors are used as instruments. To eliminate the effect of outliers the data are screened by trimming observations at the 5st and 95th percentile.
* significant at the 5% level; ** significant at the 1% level; *** significant at the 0.1% level

Table 3.8: Quantile Regression – Sectors

Sector	Variable	q10	q20	q30	q40	q50	q60	q70	q80	q90
Agriculture	$(I/K)_{i.t-1}$	0.0945***	0.0549***	0.1789***	0.1628***	0.3559***	0.3068***	0.1249***	0.2160***	0.1515***
		(0.0036)	(0.0036)	(0.0159)	(0.0001)	(0.0050)	(0.0058)	(0.0336)	(0.0054)	(0.0000)
	$(CF/K)_{i.t-1}$	0.0324***	0.0131***	0.0652***	0.0818***	0.1336***	0.1127***	0.2443***	0.3376***	0.2626***
		(0.0058)	(0.0008)	(0.0034)	(0.0002)	(0.0149)	(0.0032)	(0.0064)	(0.0015)	(0.0000)
	$(GS/K)_{i.t-1}$	-0.0009	0.0197***	-0.0031***	0.0013***	-0.0009	0.0186***	0.0571***	0.0557***	0.0850***
		(0.0016)	(0.0003)	(0.0009)	(0.0001)	(0.0013)	(0.0014)	(0.0010)	(0.0006)	(0.0000)
	h_{t-1}	-0.0036***	-0.0018***	-0.0067***	-0.0008***	-0.0005*	-0.0009	-0.0032	-0.0127***	-0.0288***
		(0.0009)	(0.0001)	(0.0012)	(0.0000)	(0.0003)	(0.0006)	(0.0024)	(0.0002)	(0.0000)
	$id_{i.t-1}$	0.0075***	0.0051***	-0.0019	0.0072***	-0.0037***	0.0003	-0.0069***	-0.0073***	0.0253***
		(0.0010)	(0.0006)	(0.0012)	(0.0000)	(0.0006)	(0.0012)	(0.0011)	(0.0007)	(0.0000)
	Observations	746	746	746	746	746	746	746	746	746
	Variable	q10	q20	q30	q40	q50	q60	q70	q80	q90
Mining	$(I/K)_{i.t-1}$	0.1670***	0.0685***	0.1525***	0.2415***	0.2107***	0.1827***	0.2235***	0.2192***	-0.0041
		(0.0053)	(0.0010)	(0.0108)	(0.0279)	(0.0060)	(0.0014)	(0.0000)	(0.0000)	(0.0222)
	$(CF/K)_{i.t-1}$	0.0293***	0.0057***	0.0322***	0.0089***	0.0260***	0.0255***	-0.0051***	-0.0350***	-0.0389***
		(0.0022)	(0.0011)	(0.0032)	(0.0004)	(0.0013)	(0.0004)	(0.0000)	(0.0000)	(0.0042)
	$(GS/K)_{i.t-1}$	0.0259**	0.0154***	0.0326***	0.0301***	0.0085	0.0078***	-0.0864***	0.0538***	0.1271***
		(0.0122)	(0.0007)	(0.0024)	(0.0048)	(0.0052)	(0.0004)	(0.0000)	(0.0000)	(0.0087)
	h_{t-1}	-0.0228***	-0.0068***	0.0016	-0.0048***	-0.0126***	-0.0163***	-0.0250***	-0.0292***	-0.0284***
		(0.0001)	(0.0003)	(0.0017)	(0.0003)	(0.0006)	(0.0002)	(0.0000)	(0.0000)	(0.0038)
	$id_{i.t-1}$	-0.0306***	-0.0017***	0.0092***	0.0094***	0.0096***	0.0209***	0.0430***	0.0179***	0.0392***
		(0.0011)	(0.0003)	(0.0016)	(0.0021)	(0.0011)	(0.0002)	(0.0000)	(0.0000)	(0.0052)
	Observations	507	507	507	507	507	507	507	507	507
	Variable	q10	q20	q30	q40	q50	q60	q70	q80	q90
Fishing	$(I/K)_{i.t-1}$	0.1334***	0.1908***	0.3021***	0.2926***	0.4826***	0.5191***	0.7455***	0.4897***	0.4846***
		(0.0139)	(0.0043)	(0.0070)	(0.0098)	(0.0001)	(0.0195)	(0.0002)	(0.0119)	(0.0004)
	$(CF/K)_{i.t-1}$	0.0121***	-0.0146***	0.0004	0.0041***	0.0157***	0.0183***	-0.0177***	0.0126***	0.0489***
		(0.0038)	(0.0033)	(0.0006)	(0.0010)	(0.0000)	(0.0028)	(0.0000)	(0.0026)	(0.0000)
	$(GS/K)_{i.t-1}$	0.0619***	0.0016	0.0047***	0.0455***	-0.0044***	0.0858***	-0.1288***	0.1335***	0.1853***
		(0.0101)	(0.0055)	(0.0016)	(0.0043)	(0.0000)	(0.0055)	(0.0001)	(0.0092)	(0.0003)
	h_{t-1}	-0.0040**	-0.0089***	0.0028*	-0.0044***	-0.0082***	-0.0047***	-0.0264***	-0.0219***	-0.0321***
		(0.0015)	(0.0005)	(0.0015)	(0.0006)	(0.0000)	(0.0015)	(0.0000)	(0.0010)	(0.0000)
	$id_{i.t-1}$	-0.0013	-0.0202***	-0.0056***	-0.0017	0.0260***	0.0221***	0.0215***	0.0120***	0.0185***
		(0.0027)	(0.0006)	(0.0007)	(0.0023)	(0.0000)	(0.0009)	(0.0000)	(0.0016)	(0.0000)
	Observations	347	347	347	347	347	347	347	347	347

Notes: The models are estimated using a two-step GMM method developed by Powell (2014) and implemented in STATA 14. The estimations are based on the Markov Chain Monte Carlo (MCMC) optimization method. Robust standard errors are reported in braces. The h term is the measure of economic uncertainty. while the id term refers to the idiosyncratic uncertainty. Current values of h_{t-1} and one-period lagged values for the rest of the regressors are used as instruments. To eliminate the effect of outliers the data are screened by trimming observations at the 5st and 95th percentile.
* significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level

Table 3.9: Quantile Regression – Sectors

Sector	Variable	q10	q20	q30	q40	q50	q60	q70	q80	q90
Hotels & Restaurants	$(I/K)_{i.t-1}$	0.0216***	0.0195***	0.0426***	0.0519***	0.0775***	0.1207***	0.1586***	0.1663***	0.1253***
		(0.0003)	(0.0003)	(0.0009)	(0.0004)	(0.0005)	(0.0000)	(0.0000)	(0.0000)	(0.0012)
	$(CF/K)_{i.t-1}$	0.0122***	0.0072***	0.0259***	0.0234***	0.0389***	0.0354***	0.0685***	0.0760***	0.1895***
		(0.0006)	(0.0009)	(0.0012)	(0.0007)	(0.0002)	(0.0000)	(0.0000)	(0.0000)	(0.0007)
	$(GS/K)_{i.t-1}$	0.0416***	0.0460***	0.0818***	0.1144***	0.1536***	0.2120***	0.2665***	0.3155***	0.3528***
		(0.0006)	(0.0002)	(0.0003)	(0.0009)	(0.0006)	(0.0000)	(0.0000)	(0.0000)	(0.0008)
	h_{t-1}	-0.0007***	-0.0013***	-0.0010***	-0.0038***	-0.0060***	-0.0088***	-0.0140***	-0.0219***	-0.0297***
		(0.0000)	(0.0000)	(0.0001)	(0.0000)	(0.0001)	(0.0000)	(0.0000)	(0.0000)	(0.0001)
	$id_{i.t-1}$	0.0023***	0.0027***	0.0058***	0.0090***	0.0050***	0.0032***	0.0096***	0.0200***	0.0292***
		(0.0000)	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0000)	(0.0000)	(0.0000)	(0.0009)
	Observations	11777	11777	11777	11777	11777	11777	11777	11777	11777
	Variable	q10	q20	q30	q40	q50	q60	q70	q80	q90
Trade	$(I/K)_{i.t-1}$	0.0502***	0.0373***	0.0649***	0.1020***	0.1423***	0.2082***	0.2102***	0.2378***	0.2077***
		(0.0011)	(0.0001)	(0.0000)	(0.0002)	(0.0000)	(0.0001)	(0.0000)	(0.0000)	(0.0001)
	$(CF/K)_{i.t-1}$	0.0020***	0.0013***	0.0016***	0.0018***	0.0020***	0.0028***	0.0022***	0.0011***	0.0010***
		(0.0001)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
	$(GS/K)_{i.t-1}$	0.0060***	0.0082***	0.0145***	0.0246***	0.0340***	0.0449***	0.0533***	0.0634***	0.0684***
		(0.0001)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
	h_{t-1}	-0.0072***	-0.0036***	-0.0040***	-0.0063***	-0.0099***	-0.0149***	-0.0206***	-0.0258***	-0.0272***
		(0.0006)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
	$id_{i.t-1}$	-0.0001***	-0.0000***	0.0001***	0.0001***	0.0001***	0.0001***	0.0007***	0.0009***	0.0017***
		(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
	Observations	29428	29428	29428	29428	29428	29428	29428	29428	29428
	Variable	q10	q20	q30	q40	q50	q60	q70	q80	q90
Manufacturing	$(I/K)_{i.t-1}$	0.0441***	0.0564***	0.0921***	0.1388***	0.1808***	0.2104***	0.2492***	0.2597***	0.2958***
		(0.0001)	(0.0001)	(0.0003)	(0.0003)	(0.0003)	(0.0001)	(0.0000)	(0.0012)	(0.0000)
	$(CF/K)_{i.t-1}$	0.0091***	0.0056***	0.0093***	0.0103***	0.0139***	0.0145***	0.0168***	0.0136***	0.0304***
		(0.0001)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0002)	(0.0000)
	$(GS/K)_{i.t-1}$	0.0318***	0.0370***	0.0570***	0.0805***	0.0975***	0.1215***	0.1480***	0.1944***	0.1897***
		(0.0002)	(0.0001)	(0.0001)	(0.0000)	(0.0001)	(0.0000)	(0.0000)	(0.0003)	(0.0000)
	h_{t-1}	-0.0027***	-0.0026***	-0.0034***	-0.0050***	-0.0074***	-0.0105***	-0.0140***	-0.0194***	-0.0263***
		(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
	$id_{i.t-1}$	-0.0020***	-0.0002***	0.0004***	0.0008***	0.0016***	0.0033***	0.0044***	0.0052***	0.0084***
		(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
	Observations	21400	21400	21400	21400	21400	21400	21400	21400	21400

Notes: The models are estimated using a two-step GMM method developed by Powell (2014) and implemented in STATA 14. The estimations are based on the Markov Chain Monte Carlo (MCMC) optimization method. Robust standard errors are reported in braces. The h term is the measure of economic uncertainty. while the id term refers to the idiosyncratic uncertainty. Current values of h_{t-1} and one-period lagged values for the rest of the regressors are used as instruments. To eliminate the effect of outliers the data are screened by trimming observations at the 5st and 95th percentile.
* significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level

Table 3.10: Quantile Regression – Sectors

Sector	Variable	q10	q20	q30	q40	q50	q60	q70	q80	q90
Construction	$(I/K)_{i.t-1}$	0.0974***	0.0376***	0.0552***	0.0664***	0.1040***	0.1308***	0.1372***	0.1611***	0.1505***
		(0.0013)	(0.0003)	(0.0011)	(0.0002)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0007)
	$(CF/K)_{i.t-1}$	0.0036***	0.0005***	0.0016***	0.0022***	0.0023***	0.0019***	0.0008***	0.0001***	-0.0018***
		(0.0006)	(0.0000)	(0.0001)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0003)
	$(GS/K)_{i.t-1}$	0.0242***	0.0078***	0.0119***	0.0236***	0.0301***	0.0501***	0.0585***	0.0709***	0.0890***
		(0.0020)	(0.0001)	(0.0006)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0009)
	h_{t-1}	-0.0050***	-0.0050***	-0.0021***	-0.0066***	-0.0131***	-0.0187***	-0.0231***	-0.0259***	-0.0230***
		(0.0004)	(0.0000)	(0.0005)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0009)
	$id_{i.t-1}$	-0.0004***	-0.0002***	0.0000***	0.0002***	0.0006***	0.0005***	0.0015***	0.0016***	0.0040***
		(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0004)
	Observations	6763	6763	6763	6763	6763	6763	6763	6763	6763
	Variable	q10	q20	q30	q40	q50	q60	q70	q80	q90
Real Estate	$(I/K)_{i.t-1}$	0.0240***	0.0074***	0.0184***	0.0485***	0.0870***	0.1860***	0.2386***	0.2607***	0.2350***
		(0.0024)	(0.0029)	(0.0007)	(0.0003)	(0.0000)	(0.0003)	(0.0000)	(0.0000)	(0.0000)
	$(CF/K)_{i.t-1}$	0.0065***	-0.0009	0.0006***	-0.0006***	-0.0016***	-0.0015***	-0.0065***	-0.0045***	-0.0010***
		(0.0017)	(0.0019)	(0.0001)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
	$(GS/K)_{i.t-1}$	0.0197***	0.0047*	0.0150***	0.0290***	0.0413***	0.0576***	0.0665***	0.0747***	0.0751***
		(0.0052)	(0.0025)	(0.0002)	(0.0000)	(0.0000)	(0.0001)	(0.0000)	(0.0000)	(0.0000)
	h_{t-1}	-0.0055***	-0.0009	-0.0004	-0.0017***	-0.0046***	-0.0107***	-0.0175***	-0.0276***	-0.0323***
		(0.0008)	(0.0008)	(0.0004)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
	$id_{i.t-1}$	-0.0027***	0.0001**	0.0001***	0.0003***	0.0002***	-0.0001***	-0.0000***	0.0018***	0.0046***
		(0.0007)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
	Observations	3285	3285	3285	3285	3285	3285	3285	3285	3285
	Variable	q10	q20	q30	q40	q50	q60	q70	q80	q90
Transport	$(I/K)_{i.t-1}$	0.0511***	0.0157***	0.0527***	0.0779***	0.1204***	0.2323***	0.2434***	0.1825***	0.1218***
		(0.0012)	(0.0003)	(0.0017)	(0.0003)	(0.0001)	(0.0008)	(0.0002)	(0.0011)	(0.0001)
	$(CF/K)_{i.t-1}$	0.0052***	0.0010***	0.0023***	0.0021***	0.0028***	0.0050***	0.0011***	0.0005***	0.0042***
		(0.0001)	(0.0000)	(0.0001)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0001)	(0.0000)
	$(GS/K)_{i.t-1}$	0.0137***	0.0033***	0.0119***	0.0236***	0.0337***	0.0466***	0.0496***	0.0613***	0.0674***
		(0.0003)	(0.0001)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0001)	(0.0000)
	h_{t-1}	-0.0078***	-0.0017***	0.0009*	-0.0042***	-0.0102***	-0.0192***	-0.0223***	-0.0301***	-0.0294***
		(0.0001)	(0.0001)	(0.0005)	(0.0001)	(0.0000)	(0.0000)	(0.0000)	(0.0004)	(0.0000)
	$id_{i.t-1}$	-0.0008***	-0.0001***	0.0001***	0.0003***	0.0004***	-0.0001***	0.0003***	0.0005***	0.0015***
		(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
	Observations	4082	4082	4082	4082	4082	4082	4082	4082	4082

Notes: The models are estimated using a two-step GMM method developed by Powell (2014) and implemented in STATA 14. The estimations are based on the Markov Chain Monte Carlo (MCMC) optimization method. Robust standard errors are reported in braces. The h term is the measure of economic uncertainty. while the id term refers to the idiosyncratic uncertainty. Current values of h_{t-1} and one-period lagged values for the rest of the regressors are used as instruments. To eliminate the effect of outliers the data are screened by trimming observations at the 5st and 95th percentile.
* significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level

Table 3.11: Quantile Regression – Manufacturing two-digit Subsectors (NACE Rev. 1.1 & ISIC 3.1)

	Variable	q10	q20	q30	q40	q50	q60	q70	q80	q90
Food & Beverages	$(I/K)_{i.t-1}$	0.0353***	0.0769***	0.1231***	0.2009***	0.2067***	0.0540***	0.2672***	0.3036***	0.2341***
		(0.0002)	(0.0019)	(0.0013)	(0.0024)	(0.0001)	(0.0010)	(0.0000)	(0.0001)	(0.0012)
	$(CF/K)_{i.t-1}$	0.0226***	0.0463***	0.0716***	0.0857***	0.1278***	0.2167***	0.1694***	0.2174***	0.2378***
		(0.0005)	(0.0006)	(0.0024)	(0.0012)	(0.0001)	(0.0004)	(0.0000)	(0.0000)	(0.0018)
	$(GS/K)_{i.t-1}$	0.0096***	0.0089***	0.0117***	0.0130***	0.0123***	0.0004***	0.0208***	0.0182***	0.0128***
		(0.0001)	(0.0001)	(0.0004)	(0.0001)	(0.0000)	(0.0001)	(0.0000)	(0.0000)	(0.0003)
	h_{t-1}	-0.0034***	-0.0031***	-0.0041***	-0.0057***	-0.0110***	-0.0114***	-0.0147***	-0.0180***	-0.0252***
		(0.0001)	(0.0002)	(0.0001)	(0.0001)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0002)
	$id_{i.t-1}$	-0.0022***	-0.0010***	-0.0011***	-0.0008***	-0.0003***	0.0025***	0.0009***	0.0044***	0.0128***
		(0.0000)	(0.0001)	(0.0002)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0002)
	Observations	6012	6012	6012	6012	6012	6012	6012	6012	6012
	Variable	q10	q20	q30	q40	q50	q60	q70	q80	q90
Textiles	$(I/K)_{i.t-1}$	0.2180**	-0.0505***	0.0179***	0.0663***	0.1157***	0.0725***	0.2171***	0.3055***	-0.0548***
		(0.0920)	(0.0091)	(0.0018)	(0.0028)	(0.0044)	(0.0042)	(0.0041)	(0.0022)	(0.0000)
	$(CF/K)_{i.t-1}$	0.0141	0.0090***	0.0311***	0.0534***	0.0513***	0.0892***	0.2085***	0.1192***	0.1467***
		(0.0174)	(0.0031)	(0.0028)	(0.0029)	(0.0039)	(0.0016)	(0.0016)	(0.0007)	(0.0000)
	$(GS/K)_{i.t-1}$	0.0163*	-0.0071***	-0.0037***	0.0036***	0.0121***	0.0087***	-0.0053***	0.0155***	0.0598***
		(0.0090)	(0.0011)	(0.0011)	(0.0008)	(0.0046)	(0.0007)	(0.0012)	(0.0015)	(0.0000)
	h_{t-1}	0.0049	-0.0003***	-0.0023***	-0.0030***	-0.0056***	-0.0116***	-0.0234***	-0.0147***	-0.0171***
		(0.0044)	(0.0001)	(0.0005)	(0.0004)	(0.0005)	(0.0002)	(0.0003)	(0.0007)	(0.0000)
	$id_{i.t-1}$	0.0009	-0.0019***	0.0041***	0.0048***	0.0093***	-0.0021***	0.0058***	0.0184***	0.0146***
		(0.0022)	(0.0001)	(0.0004)	(0.0004)	(0.0007)	(0.0008)	(0.0008)	(0.0002)	(0.0000)
	Observations	769	769	769	769	769	769	769	769	769
	Variable	q10	q20	q30	q40	q50	q60	q70	q80	q90
Wearing	$(I/K)_{i.t-1}$	0.0435***	0.0053	0.0419***	0.0361***	0.0951***	0.1419***	0.1867***	0.3209***	0.2903***
		(0.0117)	(0.0052)	(0.0041)	(0.0011)	(0.0034)	(0.0030)	(0.0000)	(0.0000)	(0.0000)
	$(CF/K)_{i.t-1}$	-0.0197	0.0125	0.0523***	0.0699***	0.1292***	0.1046***	0.2210***	0.2319***	0.2860***
		(0.0213)	(0.0080)	(0.0053)	(0.0003)	(0.0099)	(0.0051)	(0.0000)	(0.0001)	(0.0000)
	$(GS/K)_{i.t-1}$	0.0006	-0.0015**	0.0041***	0.0035***	-0.0037***	-0.0040***	0.0061***	-0.0163***	0.0071***
		(0.0025)	(0.0007)	(0.0008)	(0.0003)	(0.0009)	(0.0004)	(0.0000)	(0.0000)	(0.0000)
	h_{t-1}	-0.0076***	-0.0031***	0.0012	-0.0041***	-0.0023***	-0.0047***	-0.0152***	-0.0154***	-0.0227***
		(0.0016)	(0.0008)	(0.0054)	(0.0000)	(0.0001)	(0.0012)	(0.0000)	(0.0000)	(0.0000)
	$id_{i.t-1}$	0.0037***	0.0009***	0.0011**	0.0032***	-0.0005	0.0033***	0.0066***	0.0054***	0.0007***
		(0.0004)	(0.0003)	(0.0004)	(0.0001)	(0.0007)	(0.0004)	(0.0000)	(0.0000)	(0.0000)
	Observations	938	938	938	938	938	938	938	938	938

Notes: The models are estimated using a two-step GMM method developed by Powell (2014) and implemented in STATA 14. The estimations are based on the Markov Chain Monte Carlo (MCMC) optimization method. Robust standard errors are reported in braces. The h term is the measure of economic uncertainty. while the id term refers to the idiosyncratic uncertainty. Current values of h_{t-1} and one-period lagged values for the rest of the regressors are used as instruments. To eliminate the effect of outliers the data are screened by trimming observations at the 5st and 95th percentile.
* significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level

Table 3.12: Quantile Regression – Manufacturing two-digit Subsectors (NACE Rev. 1.1 & ISIC 3.1)

	Variable	q10	q20	q30	q40	q50	q60	q70	q80	q90
Leather	$(I/K)_{i.t-1}$	0.1583***	0.3806***	0.2048***	-0.3745	0.3050***	0.4325***	0.2130***	0.4491***	0.1635***
		(0.0002)	(0.0702)	(0.0004)	(0.3419)	(0.0432)	(0.0336)	(0.0619)	(0.0035)	(0.0045)
	$(CF/K)_{i.t-1}$	0.1979***	0.0882***	0.0753***	0.4774**	0.1055***	0.2028***	0.2760***	0.4095***	0.2220***
		(0.0006)	(0.0336)	(0.0004)	(0.2230)	(0.0159)	(0.0232)	(0.0546)	(0.0056)	(0.0005)
	$(GS/K)_{i.t-1}$	0.0149***	0.0288***	0.0007***	0.0445*	0.0041	0.0300***	-0.0355**	0.0051***	0.0172***
		(0.0000)	(0.0068)	(0.0001)	(0.0255)	(0.0095)	(0.0039)	(0.0165)	(0.0008)	(0.0005)
	h_{t-1}	-0.0086***	0.0119***	0.0043***	0.0023	-0.0134***	-0.0067***	0.0500***	-0.0392***	-0.0332***
		(0.0001)	(0.0038)	(0.0001)	(0.0022)	(0.0016)	(0.0013)	(0.0183)	(0.0002)	(0.0004)
	$id_{i.t-1}$	-0.0106***	-0.0054**	-0.0107***	-0.0259**	-0.0115*	-0.0140***	0.0726***	-0.0032***	-0.0035***
		(0.0001)	(0.0027)	(0.0003)	(0.0129)	(0.0068)	(0.0038)	(0.0161)	(0.0003)	(0.0002)
	Observations	173	173	173	173	173	173	173	173	173
	Variable	q10	q20	q30	q40	q50	q60	q70	q80	q90
Wood	$(I/K)_{i.t-1}$	-0.1431**	0.0179***	0.0881***	0.1095***	0.1374***	0.1517***	0.1960***	0.3454***	0.0711***
		(0.0618)	(0.0018)	(0.0023)	(0.0047)	(0.0016)	(0.0222)	(0.0018)	(0.0001)	(0.0000)
	$(CF/K)_{i.t-1}$	0.0699***	0.0155***	0.0417***	0.0761***	0.0658***	0.1120***	0.0998***	-0.1747***	0.3272***
		(0.0121)	(0.0044)	(0.0032)	(0.0072)	(0.0012)	(0.0189)	(0.0006)	(0.0002)	(0.0000)
	$(GS/K)_{i.t-1}$	-0.0079	0.0057***	0.0216***	0.0285***	0.0312***	0.0328***	0.0201***	0.1632***	-0.0252***
		(0.0063)	(0.0010)	(0.0012)	(0.0020)	(0.0003)	(0.0060)	(0.0003)	(0.0001)	(0.0000)
	h_{t-1}	-0.0165***	-0.0051***	-0.0033***	-0.0011	-0.0087***	-0.0151***	-0.0175***	-0.0182***	-0.0423***
		(0.0040)	(0.0004)	(0.0002)	(0.0009)	(0.0001)	(0.0013)	(0.0003)	(0.0000)	(0.0000)
	$id_{i.t-1}$	0.0009	0.0061***	0.0040***	0.0044***	0.0046***	0.0012	0.0068***	-0.0062***	0.0073***
		(0.0007)	(0.0009)	(0.0001)	(0.0004)	(0.0001)	(0.0016)	(0.0003)	(0.0000)	(0.0000)
	Observations	506	506	506	506	506	506	506	506	506
	Variable	q10	q20	q30	q40	q50	q60	q70	q80	q90
Paper	$(I/K)_{i.t-1}$	0.0368***	0.0353***	0.0691***	0.1480***	0.1299***	0.1866***	0.3749***	0.5013***	0.2100***
		(0.0005)	(0.0010)	(0.0000)	(0.0006)	(0.0000)	(0.0000)	(0.0001)	(0.0003)	(0.0020)
	$(CF/K)_{i.t-1}$	0.0461***	0.0452***	0.0976***	0.1048***	0.1471***	0.1744***	0.1842***	0.2483***	0.1509***
		(0.0008)	(0.0016)	(0.0000)	(0.0001)	(0.0000)	(0.0000)	(0.0000)	(0.0002)	(0.0017)
	$(GS/K)_{i.t-1}$	0.0102***	0.0238***	0.0142***	0.0196***	0.0314***	0.0361***	0.0052***	0.0635***	0.0147***
		(0.0006)	(0.0012)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0001)	(0.0012)
	h_{t-1}	-0.0019***	-0.0043***	-0.0037***	-0.0055***	-0.0067***	-0.0084***	-0.0088***	-0.0046***	-0.0683***
		(0.0000)	(0.0003)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0001)	(0.0006)
	$id_{i.t-1}$	-0.0038***	-0.0042***	-0.0018***	-0.0007***	0.0005***	0.0015***	0.0072***	0.0009***	0.0023***
		(0.0001)	(0.0003)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0001)
	Observations	666	666	666	666	666	666	666	666	666

Notes: The models are estimated using a two-step GMM method developed by Powell (2014) and implemented in STATA 14. The estimations are based on the Markov Chain Monte Carlo (MCMC) optimization method. Robust standard errors are reported in braces. The h term is the measure of economic uncertainty. while the id term refers to the idiosyncratic uncertainty. Current values of h_{t-1} and one-period lagged values for the rest of the regressors are used as instruments. To eliminate the effect of outliers the data are screened by trimming observations at the 5st and 95th percentile.

* significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level

Table 3.13: Quantile Regression – Manufacturing two-digit Subsectors (NACE Rev. 1.1 & ISIC 3.1)

Sector	Variable	q10	q20	q30	q40	q50	q60	q70	q80	q90
Publishing & Printing	$(I/K)_{i.t-1}$	0.0369***	0.0234***	0.0589***	0.1368***	0.1397***	0.1799***	0.2489***	0.2568***	0.3265***
		(0.0081)	(0.0045)	(0.0033)	(0.0020)	(0.0003)	(0.0082)	(0.0024)	(0.0000)	(0.0000)
	$(CF/K)_{i.t-1}$	0.0633***	0.0350***	0.0287***	0.0220***	0.0607***	0.0630***	0.0787***	0.1888***	0.1432***
		(0.0186)	(0.0022)	(0.0011)	(0.0010)	(0.0002)	(0.0057)	(0.0015)	(0.0000)	(0.0000)
	$(GS/K)_{i.t-1}$	-0.0058	0.0001	0.0004	0.0054***	0.0006***	0.0145**	0.0047***	-0.0130***	0.0118***
		(0.0056)	(0.0007)	(0.0008)	(0.0002)	(0.0000)	(0.0057)	(0.0003)	(0.0000)	(0.0000)
	h_{t-1}	0.0002	-0.0099***	-0.0039***	-0.0056***	-0.0091***	-0.0124***	-0.0205***	-0.0244***	-0.0247***
		(0.0013)	(0.0013)	(0.0005)	(0.0002)	(0.0000)	(0.0034)	(0.0003)	(0.0000)	(0.0000)
	$id_{i.t-1}$	-0.0011**	-0.0001	0.0018***	0.0008***	-0.0004***	-0.0003	-0.0008***	-0.0024***	-0.0009***
		(0.0005)	(0.0002)	(0.0004)	(0.0001)	(0.0000)	(0.0007)	(0.0002)	(0.0000)	(0.0000)
	Observations	1263	1263	1263	1263	1263	1263	1263	1263	1263
	Variable	q10	q20	q30	q40	q50	q60	q70	q80	q90
Coke & Petroleum	$(I/K)_{i.t-1}$	-1.7263**	-0.0293***	-0.2947***	0.0134**	0.1309***	0.2537***	0.2040***	0.1195***	0.1886***
		(0.8428)	(0.0063)	(0.0461)	(0.0057)	(0.0200)	(0.0001)	(0.0000)	(0.0119)	(0.0045)
	$(CF/K)_{i.t-1}$	-0.6030**	0.1166***	0.2208***	0.1909***	0.1752***	0.2034***	0.2775***	0.5401***	0.3498***
		(0.2957)	(0.0009)	(0.0072)	(0.0018)	(0.0133)	(0.0000)	(0.0000)	(0.0132)	(0.0113)
	$(GS/K)_{i.t-1}$	0.1285*	-0.0445***	-0.0562***	0.0595***	0.0553***	0.0281***	0.0101***	-0.0433***	-0.1494***
		(0.0777)	(0.0018)	(0.0073)	(0.0014)	(0.0073)	(0.0000)	(0.0000)	(0.0016)	(0.0049)
	h_{t-1}	-0.0157	-0.0069***	-0.0136***	-0.0094***	-0.0045***	-0.0057***	-0.0032***	-0.0186***	-0.0465***
		(0.0230)	(0.0004)	(0.0018)	(0.0002)	(0.0011)	(0.0000)	(0.0000)	(0.0018)	(0.0022)
	$id_{i.t-1}$	0.0228**	0.0025***	0.0136***	0.0101***	0.0106***	0.0072***	0.0045***	0.0017***	-0.0073***
		(0.0099)	(0.0001)	(0.0005)	(0.0001)	(0.0004)	(0.0000)	(0.0000)	(0.0002)	(0.0003)
	Observations	116	116	116	116	116	116	116	116	116
	Variable	q10	q20	q30	q40	q50	q60	q70	q80	q90
Chemicals	$(I/K)_{i.t-1}$	0.0358***	0.0790***	0.1220***	0.1959***	0.2438***	0.3967***	0.3815***	0.4178***	0.2513***
		(0.0024)	(0.0036)	(0.0174)	(0.0041)	(0.0113)	(0.0024)	(0.0003)	(0.0003)	(0.0043)
	$(CF/K)_{i.t-1}$	0.0391***	0.0562***	0.1048***	0.1259***	0.0827***	0.0881***	0.1217***	0.0865***	0.1823***
		(0.0019)	(0.0008)	(0.0348)	(0.0014)	(0.0010)	(0.0004)	(0.0027)	(0.0026)	(0.0060)
	$(GS/K)_{i.t-1}$	0.0084***	0.0129***	-0.0182	0.0150***	0.0200***	0.0222***	0.0279***	0.0023***	-0.0153***
		(0.0011)	(0.0008)	(0.0299)	(0.0006)	(0.0006)	(0.0001)	(0.0001)	(0.0003)	(0.0018)
	h_{t-1}	0.0012***	-0.0018***	-0.0058***	-0.0008***	-0.0028***	-0.0097***	-0.0098***	-0.0151***	-0.0262***
		(0.0002)	(0.0005)	(0.0017)	(0.0003)	(0.0001)	(0.0001)	(0.0001)	(0.0000)	(0.0010)
	$id_{i.t-1}$	0.0016***	0.0011***	-0.0070	0.0026***	0.0020***	0.0046***	0.0040***	0.0092***	0.0150***
		(0.0002)	(0.0004)	(0.0079)	(0.0001)	(0.0003)	(0.0000)	(0.0001)	(0.0001)	(0.0004)
	Observations	1486	1486	1486	1486	1486	1486	1486	1486	1486

Notes: The models are estimated using a two-step GMM method developed by Powell (2014) and implemented in STATA 14. The estimations are based on the Markov Chain Monte Carlo (MCMC) optimization method. Robust standard errors are reported in braces. The h term is the measure of economic uncertainty. while the id term refers to the idiosyncratic uncertainty. Current values of h_{t-1} and one-period lagged values for the rest of the regressors are used as instruments. To eliminate the effect of outliers the data are screened by trimming observations at the 5st and 95th percentile.
* significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level

Table 3.14: Quantile Regression – Manufacturing two-digit Subsectors (NACE Rev. 1.1 & ISIC 3.1)

Sector	Variable	q10	q20	q30	q40	q50	q60	q70	q80	q90
Rubber & Plastic	$(I/K)_{i.t-1}$	0.0165***	0.0380***	0.1026***	0.1139***	0.1669***	0.2576***	0.1501***	0.2438***	0.5429***
		(0.0004)	(0.0032)	(0.0015)	(0.0031)	(0.0049)	(0.0017)	(0.0001)	(0.0000)	(0.0000)
	$(CF/K)_{i.t-1}$	0.0176***	0.0426***	0.0627***	0.0792***	0.1018***	0.1264***	0.1983***	0.1928***	0.2704***
		(0.0002)	(0.0009)	(0.0009)	(0.0014)	(0.0011)	(0.0005)	(0.0002)	(0.0000)	(0.0000)
	$(GS/K)_{i.t-1}$	0.0126***	0.0086***	0.0114***	0.0127***	0.0180***	0.0371***	0.0308***	0.0324***	0.0152***
		(0.0004)	(0.0003)	(0.0003)	(0.0004)	(0.0006)	(0.0007)	(0.0000)	(0.0000)	(0.0000)
	h_{t-1}	-0.0001	-0.0017***	-0.0038***	-0.0094***	-0.0067***	-0.0119***	-0.0152***	-0.0206***	-0.0304***
		(0.0002)	(0.0002)	(0.0001)	(0.0014)	(0.0001)	(0.0001)	(0.0000)	(0.0000)	(0.0000)
	$id_{i.t-1}$	0.0002	-0.0007***	-0.0003***	0.0017***	0.0017***	0.0071***	0.0048***	-0.0017***	0.0179***
		(0.0002)	(0.0001)	(0.0001)	(0.0004)	(0.0004)	(0.0003)	(0.0000)	(0.0000)	(0.0000)
	Observations	1368	1368	1368	1368	1368	1368	1368	1368	1368
	Variable	q10	q20	q30	q40	q50	q60	q70	q80	q90
Non-metallic Mineral	$(I/K)_{i.t-1}$	0.0262***	0.0501***	0.0851***	0.1294***	0.1459***	0.1806***	0.1841***	0.1970***	0.2361***
		(0.0012)	(0.0015)	(0.0008)	(0.0013)	(0.0003)	(0.0005)	(0.0000)	(0.0000)	(0.0000)
	$(CF/K)_{i.t-1}$	0.0454***	0.0444***	0.0528***	0.0848***	0.0830***	0.1008***	0.1296***	0.2035***	0.1448***
		(0.0002)	(0.0027)	(0.0006)	(0.0004)	(0.0003)	(0.0004)	(0.0000)	(0.0000)	(0.0000)
	$(GS/K)_{i.t-1}$	-0.0185***	-0.0002	0.0004	0.0034***	0.0058***	0.0162***	0.0261***	0.0274***	0.0301***
		(0.0009)	(0.0008)	(0.0003)	(0.0001)	(0.0002)	(0.0003)	(0.0000)	(0.0000)	(0.0000)
	h_{t-1}	-0.0110***	-0.0040***	-0.0062***	-0.0071***	-0.0133***	-0.0137***	-0.0164***	-0.0210***	-0.0309***
		(0.0001)	(0.0003)	(0.0000)	(0.0001)	(0.0001)	(0.0003)	(0.0000)	(0.0000)	(0.0000)
	$id_{i.t-1}$	0.0036***	0.0005	0.0001*	0.0049***	0.0068***	0.0161***	0.0172***	0.0140***	0.0118***
		(0.0005)	(0.0004)	(0.0001)	(0.0002)	(0.0001)	(0.0001)	(0.0000)	(0.0000)	(0.0000)
	Observations	2123	2123	2123	2123	2123	2123	2123	2123	2123
	Variable	q10	q20	q30	q40	q50	q60	q70	q80	q90
Basic Metals	$(I/K)_{i.t-1}$	0.0416***	0.1551***	0.0484***	0.1373***	0.1971***	0.2931***	0.2843***	0.3103	-0.0514***
		(0.0003)	(0.0264)	(0.0029)	(0.0000)	(0.0002)	(0.0001)	(0.0000)	(0.0000)	(0.0000)
	$(CF/K)_{i.t-1}$	0.0314***	0.0024	0.0538***	0.0506***	0.0271***	0.0520***	0.0921***	0.1827	0.1154***
		(0.0010)	(0.0271)	(0.0004)	(0.0000)	(0.0002)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
	$(GS/K)_{i.t-1}$	0.0054***	0.0194***	0.0196***	0.0243***	0.0253***	0.0169***	0.0192***	0.0195	0.1144***
		(0.0003)	(0.0054)	(0.0003)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
	h_{t-1}	-0.0023***	0.0037**	-0.0053***	-0.0060***	-0.0087***	-0.0098***	-0.0109***	-0.0129	-0.0237***
		(0.0001)	(0.0017)	(0.0001)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
	$id_{i.t-1}$	0.0030***	-0.0000	0.0018***	0.0035***	0.0021***	0.0099***	-0.0008***	-0.0026	-0.0169***
		(0.0001)	(0.0008)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
	Observations	308	308	308	308	308	308	308	308	308

Notes: The models are estimated using a two-step GMM method developed by Powell (2014) and implemented in STATA 14. The estimations are based on the Markov Chain Monte Carlo (MCMC) optimization method. Robust standard errors are reported in braces. The h term is the measure of economic uncertainty. while the id term refers to the idiosyncratic uncertainty. Current values of h_{t-1} and one-period lagged values for the rest of the regressors are used as instruments. To eliminate the effect of outliers the data are screened by trimming observations at the 5st and 95th percentile.

* significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level

Table 3.15: Quantile Regression – Manufacturing two-digit Subsectors (NACE Rev. 1.1 & ISIC 3.1)

	Variable	q10	q20	q30	q40	q50	q60	q70	q80	q90
Fabricated Metals	$(I/K)_{i.t-1}$	0.0560***	0.0528***	0.0761***	0.1060***	0.1442***	0.1773***	0.2107***	0.1891***	0.2234***
		(0.0023)	(0.0079)	(0.0012)	(0.0014)	(0.0004)	(0.0048)	(0.0024)	(0.0104)	(0.0000)
	$(CF/K)_{i.t-1}$	0.0097**	0.0393***	0.0579***	0.0792***	0.1163***	0.1893***	0.2036***	0.2608***	0.2680***
		(0.0048)	(0.0015)	(0.0011)	(0.0009)	(0.0001)	(0.0383)	(0.0019)	(0.0027)	(0.0001)
	$(GS/K)_{i.t-1}$	0.0027***	0.0030***	0.0060***	0.0068***	0.0052***	-0.0040	-0.0001	-0.0052***	0.0163***
		(0.0002)	(0.0004)	(0.0006)	(0.0004)	(0.0002)	(0.0045)	(0.0004)	(0.0003)	(0.0000)
	h_{t-1}	-0.0014**	-0.0029***	-0.0040***	-0.0085***	-0.0109***	-0.0170***	-0.0184***	-0.0264***	-0.0223***
		(0.0005)	(0.0001)	(0.0006)	(0.0003)	(0.0001)	(0.0040)	(0.0006)	(0.0017)	(0.0000)
	$id_{i.t-1}$	0.0014***	0.0014***	0.0020***	0.0043***	0.0031***	0.0046***	0.0070***	0.0074***	-0.0001***
		(0.0005)	(0.0000)	(0.0001)	(0.0002)	(0.0000)	(0.0013)	(0.0006)	(0.0004)	(0.0000)
	Observations	2118	2118	2118	2118	2118	2118	2118	2118	2118
	Variable	q10	q20	q30	q40	q50	q60	q70	q80	q90
Machinery & Equipment	$(I/K)_{i.t-1}$	0.0343***	0.0803***	0.0887***	0.1154***	0.1568***	0.1893***	0.2118***	0.3377***	0.3148***
		(0.0127)	(0.0081)	(0.0055)	(0.0010)	(0.0036)	(0.0001)	(0.0000)	(0.0000)	(0.0000)
	$(CF/K)_{i.t-1}$	-0.0011	0.0067**	0.0391***	0.0291***	0.0592***	0.0544***	0.0828***	0.1210***	0.2466***
		(0.0017)	(0.0026)	(0.0057)	(0.0003)	(0.0034)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
	$(GS/K)_{i.t-1}$	0.0063***	0.0031***	0.0151***	0.0061***	0.0144***	0.0125***	0.0221***	0.0275***	0.0127***
		(0.0013)	(0.0008)	(0.0042)	(0.0001)	(0.0005)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
	h_{t-1}	-0.0048	-0.0037***	-0.0059***	-0.0079***	-0.0064***	-0.0121***	-0.0179***	-0.0209***	-0.0173***
		(0.0030)	(0.0009)	(0.0013)	(0.0001)	(0.0007)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
	$id_{i.t-1}$	-0.0032*	-0.0015**	0.0005	0.0019***	0.0005	0.0080***	0.0098***	0.0080***	0.0041***
		(0.0019)	(0.0007)	(0.0010)	(0.0000)	(0.0009)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
	Observations	1094	1094	1094	1094	1094	1094	1094	1094	1094
	Variable	q10	q20	q30	q40	q50	q60	q70	q80	q90
Electrical Machinery	$(I/K)_{i.t-1}$	0.1524***	0.0667***	0.0859***	0.1221***	0.2496***	0.2568***	0.1375***	-0.0522***	0.3578***
		(0.0149)	(0.0104)	(0.0127)	(0.0337)	(0.0069)	(0.0142)	(0.0122)	(0.0001)	(0.0000)
	$(CF/K)_{i.t-1}$	-0.0802***	0.0211***	0.0579	0.1007	0.0289***	0.0925***	0.1102***	0.2551***	0.1535***
		(0.0032)	(0.0043)	(0.0392)	(0.0633)	(0.0084)	(0.0102)	(0.0204)	(0.0000)	(0.0000)
	$(GS/K)_{i.t-1}$	0.0503***	0.0250***	-0.0039	0.0422***	-0.0136***	-0.0038	0.0098**	-0.0315***	-0.0480***
		(0.0022)	(0.0069)	(0.0111)	(0.0075)	(0.0027)	(0.0027)	(0.0041)	(0.0000)	(0.0000)
	h_{t-1}	-0.0062***	0.0046	-0.0037	0.0006	-0.0085***	-0.0079***	-0.0208***	-0.0409***	-0.0282***
		(0.0010)	(0.0039)	(0.0032)	(0.0014)	(0.0008)	(0.0011)	(0.0054)	(0.0000)	(0.0000)
	$id_{i.t-1}$	0.0074***	-0.0001	-0.0016	0.0076	-0.0008	0.0047**	0.0073**	0.0030***	0.0059***
		(0.0006)	(0.0017)	(0.0020)	(0.0059)	(0.0007)	(0.0020)	(0.0033)	(0.0000)	(0.0000)
	Observations	425	425	425	425	425	425	425	425	425

Notes: The models are estimated using a two-step GMM method developed by Powell (2014) and implemented in STATA 14. The estimations are based on the Markov Chain Monte Carlo (MCMC) optimization method. Robust standard errors are reported in braces. The h term is the measure of economic uncertainty. while the id term refers to the idiosyncratic uncertainty. Current values of h_{t-1} and one-period lagged values for the rest of the regressors are used as instruments. To eliminate the effect of outliers the data are screened by trimming observations at the 5st and 95th percentile.
* significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level

Table 3.16: Quantile Regression – Manufacturing two-digit Subsectors (NACE Rev. 1.1 & ISIC 3.1)

	Variable	q10	q20	q30	q40	q50	q60	q70	q80	q90
Radio, TV & Comms	$(I/K)_{i.t-1}$	0.0510	0.0105***	0.0415***	-0.0497***	0.1969	-0.2635***	0.2046***	0.4279***	0.0782***
		(0.0330)	(0.0012)	(0.0013)	(0.0067)	(0.2026)	(0.0278)	(0.0000)	(0.0019)	(0.0000)
	$(CF/K)_{i.t-1}$	-0.0823***	-0.0406***	-0.0971***	0.0521***	0.3031***	0.2049***	0.2934***	0.1678***	0.3863***
		(0.0148)	(0.0011)	(0.0062)	(0.0154)	(0.0282)	(0.0439)	(0.0000)	(0.0007)	(0.0000)
	$(GS/K)_{i.t-1}$	0.0442***	0.0029***	0.0268***	-0.0047	-0.1135***	-0.0409***	-0.0249***	0.0245***	-0.0248***
		(0.0113)	(0.0003)	(0.0015)	(0.0033)	(0.0136)	(0.0095)	(0.0000)	(0.0002)	(0.0000)
	h_{t-1}	-0.0222	-0.0068***	0.0171***	-0.0044***	-0.0085	-0.0737***	-0.0243***	-0.0155***	-0.0316***
		(0.0229)	(0.0002)	(0.0014)	(0.0008)	(0.0145)	(0.0063)	(0.0000)	(0.0001)	(0.0000)
	$id_{i.t-1}$	0.0109	0.0168***	0.0158***	0.0193***	0.0182***	0.0255***	-0.0172***	-0.0140***	-0.0141***
		(0.0135)	(0.0001)	(0.0005)	(0.0010)	(0.0066)	(0.0052)	(0.0000)	(0.0000)	(0.0000)
	Observations	92	92	92	92	92	92	92	92	92
	Variable	q10	q20	q30	q40	q50	q60	q70	q80	q90
Medical Instruments	$(I/K)_{i.t-1}$	0.0182***	0.0090	0.0814**	0.2168***	0.2449***	-0.1515***	0.3834***	0.0667***	0.0876***
		(0.0032)	(0.0082)	(0.0349)	(0.0000)	(0.0005)	(0.0014)	(0.0006)	(0.0001)	(0.0007)
	$(CF/K)_{i.t-1}$	0.0619***	0.1283***	0.0639	0.1230***	0.1137***	0.2291***	0.1327***	0.1979***	0.3088***
		(0.0009)	(0.0447)	(0.0435)	(0.0000)	(0.0015)	(0.0007)	(0.0002)	(0.0000)	(0.0017)
	$(GS/K)_{i.t-1}$	0.0238***	0.0137***	0.0090	-0.0304***	-0.0269***	-0.0559***	-0.0221***	-0.0662***	-0.1645***
		(0.0031)	(0.0051)	(0.0085)	(0.0000)	(0.0011)	(0.0002)	(0.0001)	(0.0000)	(0.0013)
	h_{t-1}	-0.0035*	0.0715	0.0045	-0.0055***	-0.0105***	-0.0040***	-0.0213***	-0.0329***	-0.0092***
		(0.0019)	(0.0448)	(0.0088)	(0.0000)	(0.0001)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
	$id_{i.t-1}$	-0.0198***	-0.0155**	0.0034***	-0.0078***	0.0002	0.0111***	-0.0011***	0.0110***	0.0332***
		(0.0008)	(0.0076)	(0.0009)	(0.0000)	(0.0002)	(0.0000)	(0.0000)	(0.0000)	(0.0007)
	Observations	155	155	155	155	155	155	155	155	155
	Variable	q10	q20	q30	q40	q50	q60	q70	q80	q90
Motor Vehicles	$(I/K)_{i.t-1}$	0.1237***	0.0708***	0.0785***	0.1849***	0.0512***	0.2628***	0.1578**	-0.0119	0.0703***
		(0.0001)	(0.0000)	(0.0000)	(0.0330)	(0.0012)	(0.0010)	(0.0648)	(0.0562)	(0.0000)
	$(CF/K)_{i.t-1}$	0.0189***	-0.0098***	0.0181***	0.0713***	0.1288***	0.0150***	0.0080	0.4391***	0.1742***
		(0.0000)	(0.0000)	(0.0001)	(0.0014)	(0.0014)	(0.0006)	(0.0346)	(0.0453)	(0.0000)
	$(GS/K)_{i.t-1}$	-0.0088***	0.0178***	0.0081***	0.0165***	-0.0112***	-0.0772***	-0.0558***	0.2738***	-0.0483***
		(0.0000)	(0.0000)	(0.0000)	(0.0023)	(0.0005)	(0.0003)	(0.0081)	(0.0444)	(0.0000)
	h_{t-1}	0.0114***	-0.0031***	0.0044***	0.0050***	-0.0021***	-0.0104***	-0.0025	-0.0022	-0.0583***
		(0.0000)	(0.0000)	(0.0000)	(0.0019)	(0.0000)	(0.0000)	(0.0016)	(0.0067)	(0.0000)
	$id_{i.t-1}$	0.0022***	0.0007***	0.0044***	-0.0046**	-0.0051***	-0.0076***	0.0198***	0.1476***	0.0011***
		(0.0000)	(0.0000)	(0.0000)	(0.0021)	(0.0002)	(0.0001)	(0.0040)	(0.0203)	(0.0000)
	Observations	140	140	140	140	140	140	140	140	140

Notes: The models are estimated using a two-step GMM method developed by Powell (2014) and implemented in STATA 14. The estimations are based on the Markov Chain Monte Carlo (MCMC) optimization method. Robust standard errors are reported in braces. The h term is the measure of economic uncertainty. while the id term refers to the idiosyncratic uncertainty. Current values of h_{t-1} and one-period lagged values for the rest of the regressors are used as instruments. To eliminate the effect of outliers the data are screened by trimming observations at the 5st and 95th percentile.

* significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level

Table 3.17: Quantile Regression – Manufacturing two-digit Subsectors (NACE Rev. 1.1 & ISIC 3.1)

	Variable	q10	q20	q30	q40	q50	q60	q70	q80	q90
Transport Equipment	$(I/K)_{i.t-1}$	0.0213***	0.0775***	0.0946***	0.1157***	0.1639***	0.1996***	0.1797***	0.2798***	0.0252***
		(0.0000)	(0.0253)	(0.0071)	(0.0032)	(0.0028)	(0.0058)	(0.0159)	(0.0002)	(0.0074)
	$(CF/K)_{i.t-1}$	0.0147***	0.1019***	0.0548***	0.0779***	0.1143***	0.0900***	0.1975***	0.2066***	0.3668***
		(0.0000)	(0.0067)	(0.0007)	(0.0040)	(0.0022)	(0.0105)	(0.0224)	(0.0003)	(0.0098)
	$(GS/K)_{i.t-1}$	-0.0011***	0.0254***	0.0085***	-0.0007	0.0045***	0.0216***	0.0017	0.0280***	0.0288***
		(0.0000)	(0.0039)	(0.0014)	(0.0005)	(0.0002)	(0.0020)	(0.0049)	(0.0001)	(0.0004)
	h_{t-1}	0.0027***	0.0078**	-0.0031**	-0.0080***	-0.0154***	-0.0084***	-0.0140***	-0.0214***	-0.0326***
		(0.0000)	(0.0035)	(0.0013)	(0.0005)	(0.0001)	(0.0012)	(0.0044)	(0.0000)	(0.0008)
	$id_{i.t-1}$	0.0039***	0.0062***	-0.0000	-0.0006*	-0.0042***	-0.0090***	-0.0008	-0.0113***	0.0216***
		(0.0000)	(0.0010)	(0.0004)	(0.0004)	(0.0004)	(0.0004)	(0.0039)	(0.0000)	(0.0011)
	Observations	219	219	219	219	219	219	219	219	219
	Variable	q10	q20	q30	q40	q50	q60	q70	q80	q90
Furniture	$(I/K)_{i.t-1}$	0.0845***	0.0305***	0.0314***	0.0352***	0.1626***	0.8901***	0.0882***	0.1405***	0.1787***
		(0.0039)	(0.0026)	(0.0038)	(0.0054)	(0.0100)	(0.0119)	(0.0059)	(0.0000)	(0.0097)
	$(CF/K)_{i.t-1}$	0.0218***	0.0420***	0.0689***	0.1082***	0.0747***	0.4618***	0.2012***	0.1914***	0.2719***
		(0.0030)	(0.0094)	(0.0042)	(0.0010)	(0.0139)	(0.0047)	(0.0028)	(0.0000)	(0.0061)
	$(GS/K)_{i.t-1}$	-0.0045*	0.0056***	0.0048**	0.0103***	0.0155***	-0.1166***	-0.0074***	-0.0126***	0.0093***
		(0.0027)	(0.0007)	(0.0024)	(0.0003)	(0.0017)	(0.0021)	(0.0010)	(0.0000)	(0.0034)
	h_{t-1}	-0.0200	-0.0036***	-0.0038***	-0.0024***	-0.0075***	0.0375***	0.0026	-0.0189***	-0.0117***
		(0.0130)	(0.0008)	(0.0002)	(0.0003)	(0.0005)	(0.0008)	(0.0054)	(0.0000)	(0.0005)
	$id_{i.t-1}$	0.0080***	0.0033***	0.0056***	0.0041***	0.0142***	0.0281***	0.0013	0.0081***	0.0018*
		(0.0017)	(0.0007)	(0.0001)	(0.0004)	(0.0016)	(0.0003)	(0.0016)	(0.0000)	(0.0011)
	Observations	1172	1172	1172	1172	1172	1172	1172	1172	1172
	Variable	q10	q20	q30	q40	q50	q60	q70	q80	q90
Recycling	$(I/K)_{i.t-1}$	-0.0553***	0.5082***	0.1335***	0.1968***	0.3228***	0.3199***	0.3924***	0.3454***	0.3670***
		(0.0106)	(0.0975)	(0.0515)	(0.0041)	(0.0574)	(0.0012)	(0.0075)	(0.0151)	(0.0106)
	$(CF/K)_{i.t-1}$	0.0430	-0.1975***	0.1042***	0.1533***	0.1306***	0.2237***	0.3251***	0.2421***	0.3498***
		(0.0446)	(0.0550)	(0.0100)	(0.0044)	(0.0477)	(0.0006)	(0.0103)	(0.0080)	(0.0168)
	$(GS/K)_{i.t-1}$	0.0096*	0.0002	0.0040	0.0296***	0.0161***	0.0223***	0.0354***	0.0601***	0.0115**
		(0.0055)	(0.0048)	(0.0026)	(0.0010)	(0.0052)	(0.0002)	(0.0018)	(0.0023)	(0.0053)
	h_{t-1}	0.0123**	-0.0018	-0.0112***	-0.0143***	-0.0098***	-0.0130***	-0.0253***	-0.0181***	-0.0398***
		(0.0054)	(0.0019)	(0.0037)	(0.0014)	(0.0013)	(0.0001)	(0.0010)	(0.0010)	(0.0017)
	$id_{i.t-1}$	-0.0107***	-0.0018	-0.0092***	0.0176***	0.0038***	0.0014***	-0.0016**	0.0101***	-0.0233***
		(0.0015)	(0.0012)	(0.0013)	(0.0009)	(0.0001)	(0.0001)	(0.0006)	(0.0011)	(0.0016)
	Observations	188	188	188	188	188	188	188	188	188

Notes: The models are estimated using a two-step GMM method developed by Powell (2014) and implemented in STATA 14. The estimations are based on the Markov Chain Monte Carlo (MCMC) optimization method. Robust standard errors are reported in braces. The h term is the measure of economic uncertainty. while the id term refers to the idiosyncratic uncertainty. Current values of h_{t-1} and one-period lagged values for the rest of the regressors are used as instruments. To eliminate the effect of outliers the data are screened by trimming observations at the 5st and 95th percentile.
* significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level

Table 3.18: Robustness Analysis – Leverage Effect

Variable	q1	q5	q10	q15	q20	q25	q30	q35	q40	q45
$(I/K)_{i.t-1}$	0.0120***	0.0552***	0.0254***	0.0224***	0.0308***	0.0470***	0.0602***	0.0801***	0.1002***	0.1256***
	(0.0018)	(0.0007)	(0.0001)	(0.0001)	(0.0002)	(0.0004)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
$(CF/K)_{i.t-1}$	-0.0012	-0.0305***	0.0102***	0.0110***	0.0150***	0.0211***	0.0272***	0.0334***	0.0398***	0.0444***
	(0.0008)	(0.0009)	(0.0000)	(0.0000)	(0.0000)	(0.0001)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
$(GS/K)_{i.t-1}$	0.0044***	-0.0004***	0.0033***	0.0024***	0.0026***	0.0026***	0.0029***	0.0035***	0.0040***	0.0044***
	(0.0002)	(0.0001)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
h_{t-1}	-0.0075***	-0.0123***	-0.0054***	-0.0030***	-0.0028***	-0.0032***	-0.0045***	-0.0054***	-0.0062***	-0.0082***
	(0.0001)	(0.0001)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
$(D/K)_{it-1}$	-0.0052***	-0.0068***	-0.0032***	-0.0010***	0.0001***	0.0002***	0.0009***	0.0014***	0.0022***	0.0027***
	(0.0002)	(0.0001)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
$id_{i.t-1}$	0.0000	-0.0010***	-0.0004***	-0.0001***	-0.0001***	-0.0001***	-0.0002***	-0.0002***	-0.0002***	-0.0004***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Variable	q50	q55	q60	q65	q70	q75	q80	q85	q90	q95
$(I/K)_{i.t-1}$	0.1412***	0.1646***	0.1820***	0.2059***	0.2249***	0.2394***	0.2546***	0.2575***	0.2559***	0.2154***
	(0.0001)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0003)
$(CF/K)_{i.t-1}$	0.0504***	0.0564***	0.0660***	0.0726***	0.0797***	0.0884***	0.0991***	0.1092***	0.1181***	0.1207***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
$(GS/K)_{i.t-1}$	0.0046***	0.0046***	0.0041***	0.0045***	0.0051***	0.0050***	0.0044***	0.0047***	0.0031***	0.0021***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
h_{t-1}	-0.0095***	-0.0115***	-0.0136***	-0.0156***	-0.0189***	-0.0220***	-0.0258***	-0.0286***	-0.0306***	-0.0329***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
$(D/K)_{it-1}$	0.0031***	0.0040***	0.0041***	0.0057***	0.0069***	0.0081***	0.0100***	0.0124***	0.0147***	0.0180***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
$id_{i.t-1}$	-0.0001***	-0.0001***	0.0000***	0.0001***	0.0002***	0.0004***	0.0005***	0.0007***	0.0014***	0.0013***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Observations	57481	57481	57481	57481	57481	57481	57481	57481	57481	57481

Notes: The model is estimated using a two-step GMM method developed by Powell (2014) and implemented in STATA 14. The estimation is based on the Markov Chain Monte Carlo (MCMC) optimization method. Robust standard errors are reported in braces. The h term is the measure of economic uncertainty. while the id term refers to the idiosyncratic uncertainty. Current values of h_{t-1} and one-period lagged values for the rest of the regressors are used as instruments. To eliminate the effect of outliers the data are screened by trimming observations at the 5st and 95th percentile.
* significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level

Table 3.19: Robustness Analysis – Interaction Effects

Variable	q1	q5	q10	q15	q20	q25	q30	q35	q40	q45
$(I/K)_{i.t-1}$	0.0152**	0.0444***	0.0220***	0.0214***	0.0288***	0.0425***	0.0582***	0.0761***	0.0970***	0.1183***
	(0.0064)	(0.0060)	(0.0001)	(0.0001)	(0.0001)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
$(CF/K)_{i.t-1}$	0.0022**	0.0117***	0.0140***	0.0130***	0.0172***	0.0248***	0.0307***	0.0389***	0.0435***	0.0495***
	(0.0010)	(0.0011)	(0.0000)	(0.0001)	(0.0001)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
$(GS/K)_{i.t-1}$	0.0034***	0.0055***	0.0039***	0.0022***	0.0024***	0.0027***	0.0033***	0.0036***	0.0043***	0.0049***
	(0.0004)	(0.0003)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
h_{t-1}	-0.0075***	-0.0081***	-0.0054***	-0.0023***	-0.0021***	-0.0028***	-0.0034***	-0.0044***	-0.0057***	-0.0070***
	(0.0004)	(0.0004)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
$(D/K)_{it-1}$	-0.0067***	-0.0055***	-0.0032***	-0.0012***	-0.0002***	0.0001***	0.0007***	0.0008***	0.0016***	0.0022***
	(0.0002)	(0.0002)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
$h_{t-1}x(GS/K)_{i.t-1}$	0.0002**	0.0012***	0.0006***	0.0001**	-0.0002***	-0.0005***	-0.0007***	-0.0008***	-0.0009***	-0.0011***
	(0.0001)	(0.0002)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
$h_{t-1}x(CF/K)_{i.t-1}$	-0.0007***	-0.0000	-0.0002***	-0.0021***	-0.0028***	-0.0044***	-0.0054***	-0.0064***	-0.0061***	-0.0067***
	(0.0002)	(0.0003)	(0.0000)	(0.0001)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
$id_{i.t-1}$	0.0000	-0.0009***	-0.0004***	-0.0001***	-0.0001***	-0.0001***	-0.0001***	-0.0001***	-0.0002***	-0.0002***
	(0.0001)	(0.0002)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)

Variable	q50	q55	q60	q65	q70	q75	q80	q85	q90	q95
$(I/K)_{i.t-1}$	0.1419***	0.1643***	0.1832***	0.2157***	0.2269***	0.2418***	0.2509***	0.2628***	0.2566***	0.2513***
	(0.0000)	(0.0000)	(0.0000)	(0.0004)	(0.0001)	(0.0000)	(0.0001)	(0.0000)	(0.0000)	(0.0003)
$(CF/K)_{i.t-1}$	0.0564***	0.0637***	0.0704***	0.0763***	0.0857***	0.0925***	0.1002***	0.1087***	0.1185***	0.1084***
	(0.0000)	(0.0000)	(0.0000)	(0.0001)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0001)
$(GS/K)_{i.t-1}$	0.0053***	0.0054***	0.0056***	0.0057***	0.0066***	0.0062***	0.0054***	0.0047***	0.0040***	0.0013***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0001)
h_{t-1}	-0.0085***	-0.0105***	-0.0126***	-0.0156***	-0.0180***	-0.0213***	-0.0252***	-0.0283***	-0.0307***	-0.0313***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
$(D/K)_{it-1}$	0.0027***	0.0032***	0.0039***	0.0045***	0.0060***	0.0072***	0.0096***	0.0119***	0.0142***	0.0178***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
$h_{t-1}x(GS/K)_{i.t-1}$	-0.0012***	-0.0012***	-0.0012***	-0.0016***	-0.0016***	-0.0016***	-0.0013***	-0.0015***	-0.0016***	-0.0023***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
$h_{t-1}x(CF/K)_{i.t-1}$	-0.0073***	-0.0078***	-0.0074***	-0.0063***	-0.0059***	-0.0048***	-0.0034***	-0.0023***	-0.0002***	0.0017***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0001)
$id_{i.t-1}$	-0.0002***	-0.0001***	-0.0000***	-0.0000***	-0.0000***	0.0004***	0.0003***	0.0006***	0.0013***	0.0017***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Observations	57481	57481	57481	57481	57481	57481	57481	57481	57481	57481

Notes: The model is estimated using a two-step GMM method developed by Powell (2014) and implemented in STATA 14. The estimation is based on the Markov Chain Monte Carlo (MCMC) optimization method. Robust standard errors are reported in braces. The h term is the measure of economic uncertainty. while the id term refers to the idiosyncratic uncertainty. Current values of h_{t-1} and one-period lagged values for the rest of the regressors are used as instruments. To eliminate the effect of outliers the data are screened by trimming observations at the 5st and 95th percentile.

* significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level

Table 3.20: Robustness Analysis – Pooled Quantile Regression & Machado and Santos Silva (2019) Regression

	Variable	q10	q20	q30	q40	q50	q60	q70	q80	q90
Pooled Quantile Regression	$(I/K)_{i.t-1}$	0.0452***	0.0314***	0.0640***	0.1026***	0.1490***	0.1878***	0.2254***	0.2412***	0.2292***
		(0.0020)	(0.0005)	(0.0013)	(0.0016)	(0.0022)	(0.0033)	(0.0046)	(0.0058)	(0.0085)
	$(CF/K)_{i.t-1}$	0.0075***	0.0099***	0.0207***	0.0336***	0.0450***	0.0594***	0.0747***	0.0926***	0.1047***
		(0.0008)	(0.0004)	(0.0006)	(0.0008)	(0.0010)	(0.0012)	(0.0020)	(0.0025)	(0.0029)
	$(GS/K)_{i.t-1}$	0.0025***	0.0019***	0.0026***	0.0031***	0.0035***	0.0039***	0.0041***	0.0038***	0.0030***
		(0.0003)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0003)	(0.0005)	(0.0007)	(0.0010)
	h_{t-1}	-0.0046***	-0.0024***	-0.0038***	-0.0061***	-0.0091***	-0.0132***	-0.0183***	-0.0241***	-0.0272***
		(0.0003)	(0.0001)	(0.0001)	(0.0001)	(0.0002)	(0.0002)	(0.0004)	(0.0005)	(0.0009)
	$id_{i.t-1}$	-0.0005***	-0.0000	0.0001	0.0001***	0.0003***	0.0007***	0.0011***	0.0017***	0.0030***
		(0.0001)	(0.0000)	(0.0000)	(0.0000)	(0.0001)	(0.0001)	(0.0002)	(0.0002)	(0.0002)
	Observations	91682	91682	91682	91682	91682	91682	91682	91682	91682
	Variable	q10	q20	q30	q40	q50	q60	q70	q80	q90
Machado and Santos Silva	$(I/K)_{i.t-1}$	-0.0063	-0.0154	-0.0216	-0.0283*	-0.0368***	-0.0488***	-0.0643***	-0.0803***	-0.1026***
		(0.0220)	(0.0192)	(0.0174)	(0.0157)	(0.0140)	(0.0128)	(0.0140)	(0.0177)	(0.0248)
	$(CF/K)_{i.t-1}$	0.0405***	0.0460***	0.0497***	0.0537***	0.0588***	0.0661***	0.0755***	0.0851***	0.0985***
		(0.0107)	(0.0093)	(0.0084)	(0.0076)	(0.0068)	(0.0062)	(0.0068)	(0.0086)	(0.0120)
	$(GS/K)_{i.t-1}$	0.0019	0.0017	0.0016	0.0014	0.0013	0.0011	0.0008	0.0005	0.0000
		(0.0023)	(0.0020)	(0.0018)	(0.0016)	(0.0015)	(0.0013)	(0.0015)	(0.0018)	(0.0026)
	h_{t-1}	-0.0130***	-0.0147***	-0.0159***	-0.0171***	-0.0187***	-0.0209***	-0.0238***	-0.0268***	-0.0309***
		(0.0017)	(0.0015)	(0.0013)	(0.0012)	(0.0011)	(0.0010)	(0.0011)	(0.0014)	(0.0019)
	$id_{i.t-1}$	0.0009	0.0010	0.0011	0.0011*	0.0012**	0.0014***	0.0016***	0.0018***	0.0020**
		(0.0008)	(0.0007)	(0.0007)	(0.0006)	(0.0005)	(0.0005)	(0.0005)	(0.0007)	(0.0009)
	Observations	91682	91682	91682	91682	91682	91682	91682	91682	91682

Notes: The models are estimated using a pooled quantile regression and the Machado and Santos Silva (2019) estimator implemented in STATA 14. Robust standard errors are reported in braces. The h term is the measure of economic uncertainty. while the id term refers to the idiosyncratic uncertainty. To eliminate the effect of outliers the data are screened by trimming observations at the 5st and 95th percentile.
* significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level

Table 3.21: Robustness Analysis – Cluster-specific regression results (Initial partition selection based on a predetermined classification of small and medium-sized enterprises)

Variable	Ω_1	Ω_2	Ω_3	Ω_4	$Pooled$
$(I/K)_{i.t-1}$	-0.209	0.083	0.104	-0.341	-0.014
$(CF/K)_{i.t-1}$	0.013	0.196	0.498	0.017	0.096
h_{t-1}	-0.040	-0.005	-0.025	0.016	-0.017
$(GS/K)_{i.t-1}$	0.003	-0.015	0.020	0.018	0.003
$id_{i.t-1}$	0.002	-0.001	-0.001	0.015	0.002
$\_cons$	0.182	0.046	0.036	0.138	0.108
N_g	359.00	383.00	278.00	268.00	1288.00
$Tbar$	8.95	8.96	8.97	8.99	8.97
N	3214	3433	2493	2408	11548
$r2\_w$	0.26	0.19	0.42	0.15	0.11
rho	0.23	0.18	0.24	0.24	0.16
$corr$	-0.14	-0.12	-0.35	-0.33	-0.08

Table 3.22: Robustness Analysis – Cluster-specific regression results (Initial partition selection based on the national statistical classification of economic activities for the six largest sectors in Greece (Manufacturing, Trading, Hotels & Restaurants, Transpor

Variable	Ω_1	Ω_2	Ω_3	Ω_4	Ω_5	Ω_6	$Pooled$
$(I/K)_{i.t-1}$	-0.173	0.301	-0.104	-0.020	-0.180	-0.318	-0.014
$(CF/K)_{i.t-1}$	-0.023	0.254	0.214	1.117	0.066	0.060	0.096
h_{t-1}	-0.026	-0.007	-0.012	-0.005	-0.058	0.019	-0.017
$(GS/K)_{i.t-1}$	0.008	-0.013	-0.082	-0.004	0.043	0.018	0.003
$id_{i.t-1}$	0.020	0.003	0.005	0.001	-0.004	0.005	0.002
$\_cons$	0.123	0.008	0.078	-0.060	0.219	0.125	0.108
N_g	330.00	237.00	163.00	159.00	169.00	230.00	1288.00
$Tbar$	8.98	8.95	8.97	8.99	8.92	8.98	8.97
N	2962	2122	1462	1429	1508	2065	11548
$r2\_w$	0.23	0.34	0.27	0.44	0.44	0.15	0.11
rho	0.28	0.21	0.24	0.49	0.16	0.24	0.16
$corr$	-0.23	-0.25	-0.27	-0.69	-0.06	-0.29	-0.08

Table 3.23: Robustness Analysis – Cluster-specific regression results (Initial partition selection based on the explanatory variables' set by using the official Stata command cluster kmeans)

Variable	Ω_1	Ω_2	Ω_3	Ω_4	Ω_5	$Pooled$
$(I/K)_{i.t-1}$	-0.128	-0.159	0.203	-0.286	-0.202	-0.014
$(CF/K)_{i.t-1}$	0.085	-0.005	0.343	0.058	1.101	0.096
h_{t-1}	-0.054	-0.024	-0.009	0.017	0.006	-0.017
$(GS/K)_{i.t-1}$	0.031	-0.002	-0.028	0.013	0.049	0.003
$id_{i.t-1}$	-0.004	0.018	0.002	0.004	0.084	0.002
$\_cons$	0.205	0.114	0.013	0.123	-0.077	0.108
N_g	205.00	389.00	292.00	259.00	143.00	1288.00
$Tbar$	8.94	8.97	8.96	8.98	8.98	8.97
N	1833	3491	2615	2325	1284	11548
$r2\_w$	0.42	0.18	0.34	0.13	0.44	0.11
rho	0.17	0.25	0.26	0.23	0.47	0.16
$corr$	-0.07	-0.21	-0.35	-0.26	-0.69	-0.08

Figure 3.13: Robustness Analysis – Cluster-specific linear prediction (Initial partition selection based on a predetermined classification of small and medium-sized enterprises)

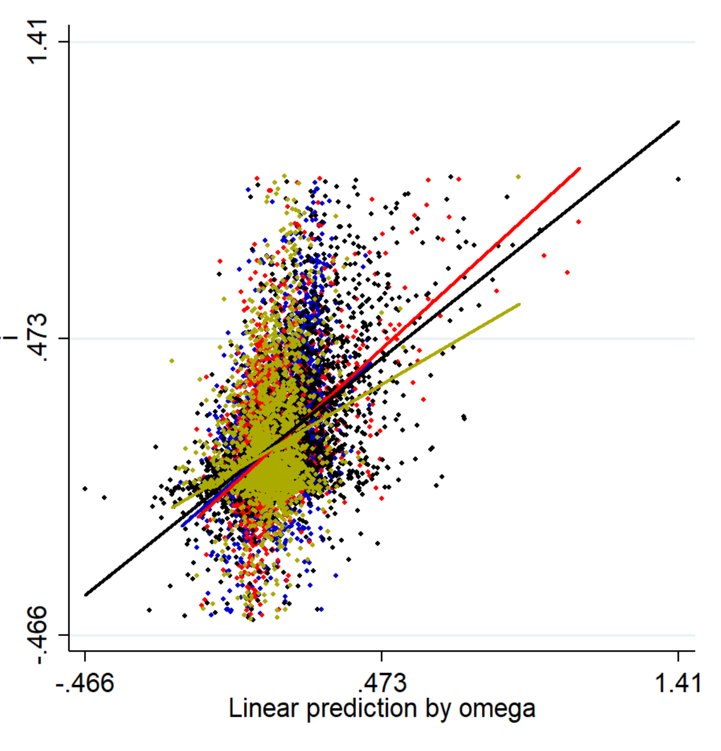


Figure 3.14: Robustness Analysis – Cluster-specific linear prediction (Initial partition selection based on the national statistical classification of economic activities for the six largest sectors in Greece (Manufacturing, Trading, Hotels & Restaurants, Transport

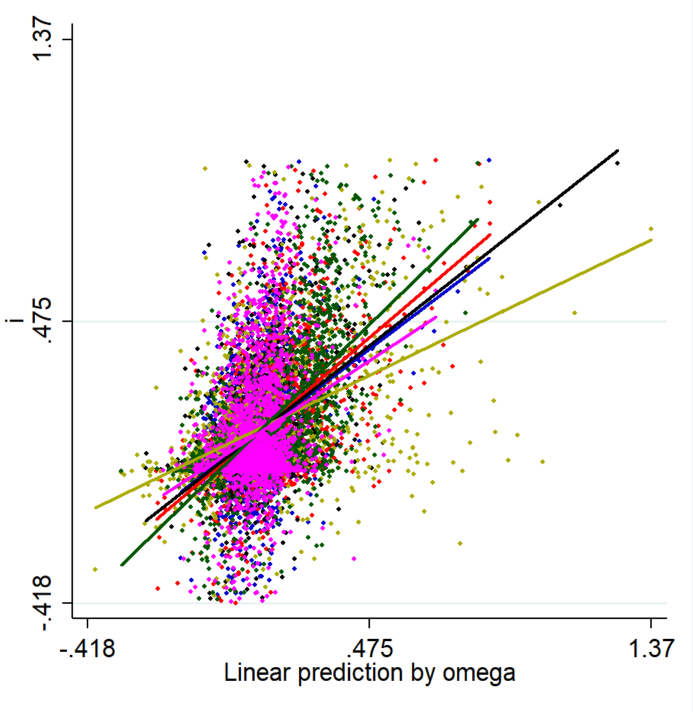


Figure 3.15: Robustness Analysis – Cluster-specific linear prediction (Initial partition selection based on the explanatory variables' set by using the official Stata command cluster kmeans)

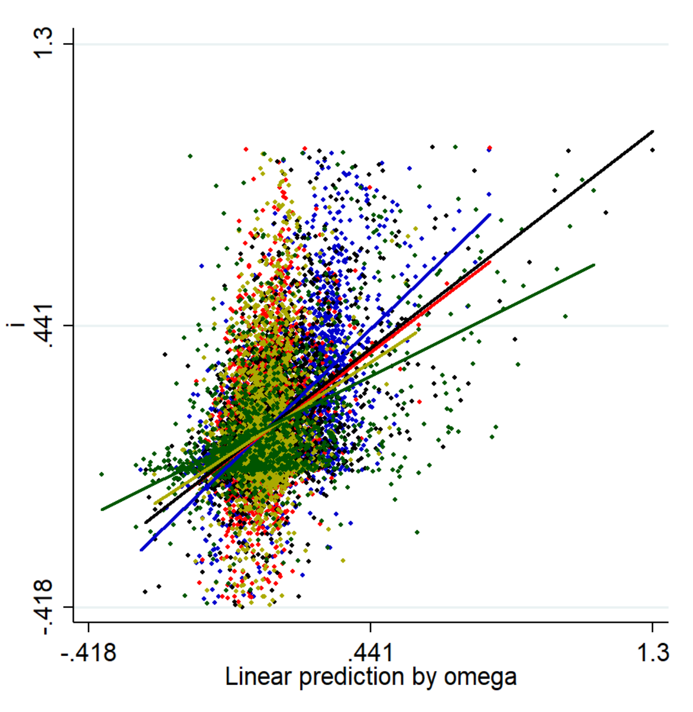


Figure 3.16: Robustness Analysis – Cluster-specific uncertainty effect (Initial partition selection based on a predetermined classification of small and medium-sized enterprises)

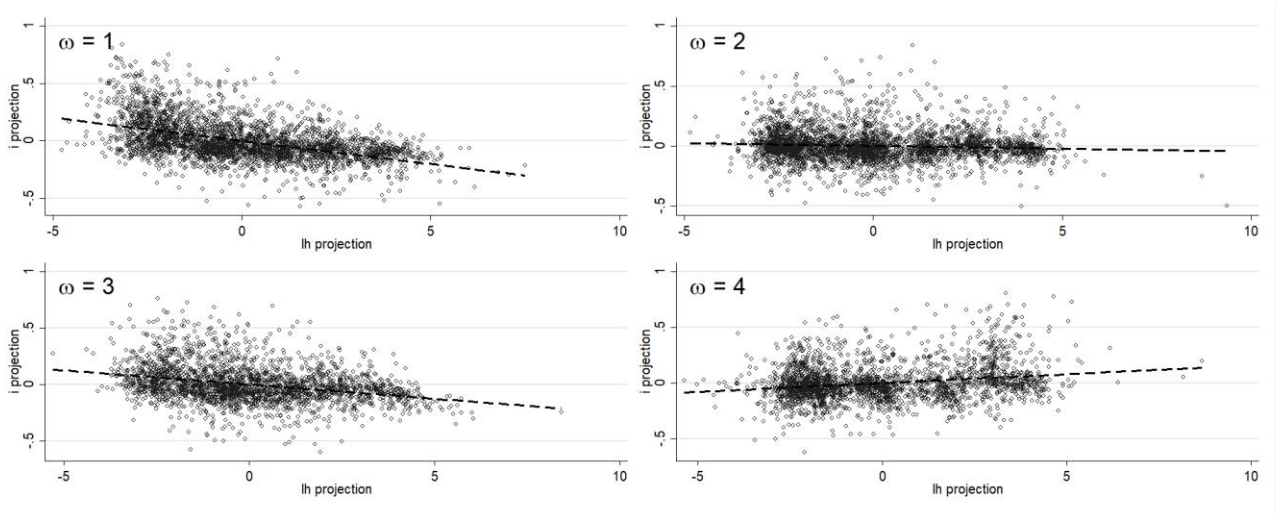
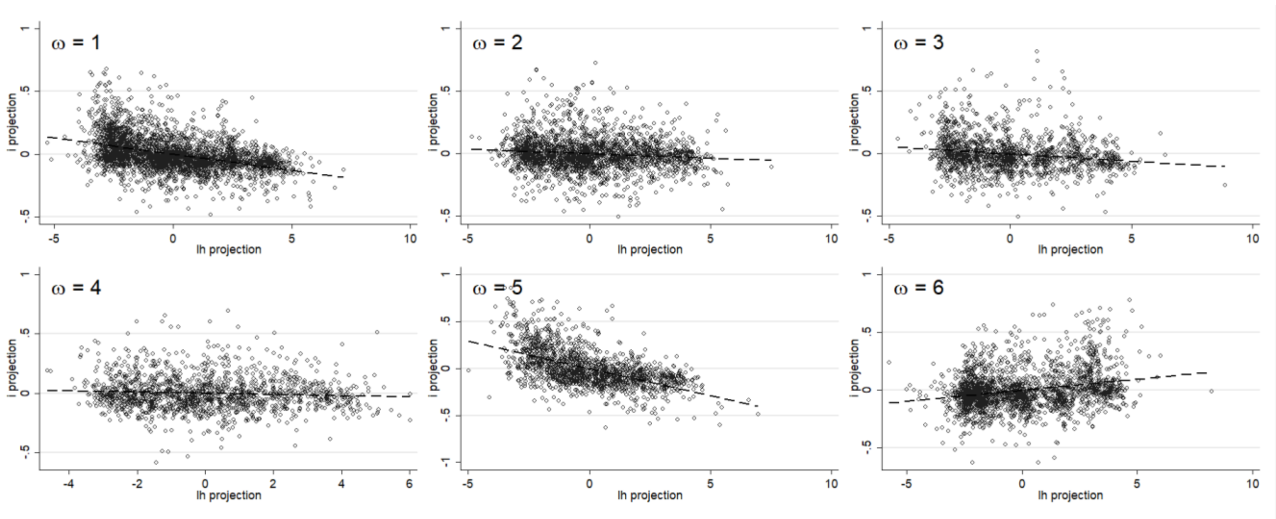


Figure 3.17: Robustness Analysis – Cluster-specific uncertainty effect ((Initial partition selection based on the national statistical classification of economic activities for the six largest sectors in Greece (Manufacturing, Trading, Hotels & Restaurants, Transports, Construction, Real Estate))



Chapter 4

Profitability under uncertainty

Abstract

We introduce an economic uncertainty index as a determinant for the Greek firms profitability. Our sample consists of 25000 firms over a 14-year time window. The uncertainty measure is obtained using a dynamic factor model. GMM estimates of a dynamic profitability model and a panel quantile regression model build our empirical research. The findings reveal a negative effect of uncertainty on the firms performance. This effect is much stronger for the less profitable Greek firm and turns positive for firms that belong to the upper quantiles of profitability rate. At the sectoral level the empirical evidence indicates the presence of between and within-sector heterogeneity.

JEL classification: C23; D22; D81; D92; G31

Keywords: Greek firms, Uncertainty, Volatility, Quantile Regression, GMM, Panel data

4.1 Introduction

Firms attempt to maximize profits. In an unstable environment of economic uncertainty managers try to minimize losses or to seize the opportunities to maximize gains. In general, the recent economic crisis has afflicted firms and corporations raising the question: "To what extend are firms exposed to uncertainty fluctuations in terms of profitability?"

Profitability is a measure of efficiency and a crucial factor that indicates the firm's performance. The identification of the determinants and sources of profitability has attracted the interest of researchers from different disciplines over time. Strategic management, economics, accounting, finance are some of the areas of knowledge that developed theoretical or empirical models to study the driving forces of profitability measure. The role and the impact of uncertainty has been thoroughly investigated only in the form of exchange rate volatility. This stream of the literature studies principally the effect of exchange rate variability on stock market returns. On the other, the literature that examines the determinants of profitability counts only a limited number of papers that take into account the impact of an economy wide uncertainty measure.

The purpose of this paper is to fill the gap in the empirical literature by introducing an economic uncertainty factor as an additional determinant of firm's profitability. Our area of interest is Greece. The Greek economy faced turbulent periods of increased volatility and a steep recession. We employ a large panel dataset of 25000 firms over a 14-year time window to create a fertile and promising field for our analysis. The uncertainty proxy is estimated by using a dynamic factor model. The empirical analysis of profitability under uncertainty is performed in a GMM estimation framework. Next, to capture heterogeneous effects we apply panel quantile estimation techniques. The analysis is extended at the sectoral level to assess the different firms behavior across sectors. The results reveal a negative impact of uncertainty on the firms performance. The use of quantile regression analysis shows that this effect is much stronger for the less profitable Greek firm. At the upper quantiles, firms with high profit rates are affected positively. The findings for each of the economic sectors provide evidence for a between- and within-sector heterogeneity.

This paper contributes to the empirical literature on determinants of firm profitability. To our knowledge, it is one of the few that includes the uncertainty effect in the determinants group. Furthermore, it is the first that applies a panel quantile model to gauge the uncertainty impact at the aggregate and at the sectoral level.

The paper is organized as follows: Section 2 reviews the theoretical and empirical literature. Section 3 outlines the econometric specification and Section 4 discusses the data and the measures of uncertainty. Results are presented in Section 5. Section 6 provides the robustness analysis and the last section concludes and provides policy implications.

4.2 Literature review

4.2.1 Firm Profitability

Researchers in industrial economics followed two broad theoretical perspectives to explain firms performance in terms of profitability rate. The first is the structure–conduct–performance (SCP) paradigm based on the neoclassical theory and the conception of the representative firm. SCP pioneered by Bain J. (1951, 1956) suggests that the market structure and industry characteristics as concentration level, barriers to entry and degree of differentiation are the key determinants for the firms profitability. A major shift from this strand of the literature which actually neglected differences across firms came in 1970s and the works of Demsetz (1973) and Peltzman (1977). The firm effects model takes into account the productivity level of each firm to measure the firm performance and to determine the competitive advantage and the concentration level. In the same spirit was the work of Jovanovic (1982) and from a strategic management perspective the papers of Porter M. (1980, 1985, 1990, 1991). Slade (2004) provides a discussion on the theoretical models of firms profitability.

The literature of empirical studies that attempt to identify profitability determinants is abundant. It is classified in three main categories. The first one examines the micro-environment of the firm and identifies the determinants that depend on the business decisions. The second one focuses on the external environment of the firm i.e. the market, the political environment, the economic conditions etc. The third approach combines the two previous categories and complements the internal profitability determinants with external factors like GDP, unemployment, crisis dummies, concentration level etc. Since we focus on the firm level we will review the empirical literature of the first and third stream.

Hurdle (1974) was one of the first who used a panel dataset to examine the firms performance. Using the absolute deviation in profits as a measure for risk found that the market structure is the strongest determinant for the explanation of profit differences. Years later, Grinyer and McKiernan (1991) studied profitability in the UK Electrical Engineering Industry and concluded that market share, growth of sales, capital intensity and decentralization have a positive effect on profitability. McDonald (1999) focusing on the Australian manufacturing sector and by applying Arellano and Bond (1991) GMM estimation found that union density and imports affect profitability negatively, profit margins are persistent over time and the effect of wages inflation is negative. Goddard et al. (2005) employ the same estimation method and suggest that the relationships profitability-size and profitability-gearing are negative while the profitability-market share and profitability-liquidity relationships are positive. Recently, Weidman et al. (2019) examined a sample of USA, German and Japanese manufacturing firms. They proposed that the net profit margin has the greatest impact on ROE.

In Greece, Papadogonas (2007) examined the financial performance of large and small firms. The effect of size, debt structure, investment rate and sales growth on profitability found to be significantly positive. Agiomirgianakis et al. (2013) studied the impact of economic crisis on the Greek tourism sector. Their findings show that sales (as a size proxy), age and inventories over total assets ratio affect profitability negatively. The effect of the crisis proxy (interest rate spreads) and of the leverage is negative. The crisis effect on the Greek hospitality industry were examined by Dimitropoulos (2017). He suggested that sales, size and cash flow have a positive effect while increased levels of leverage and capital intensity decrease profitability.

Table 2 reviews some of the most important works on profitability rate with reference to the different determinants defined in each study. They cover Europe, USA and few of them Greece. Lagged profitability rate, age, leverage, sales, cash flow and market share are the most commonly used among others.

4.2.2 Profitability & Uncertainty

The effect of an economic uncertainty index on profitability rate hasn't received much attention in the literature . However, there is a noteworthy number of theoretical and empirical papers which examine the impact of exchange rate volatility, as a measure of uncertainty, on firm performance. The early theoretical works belong to Shapiro (1975) and Dumas (1978) who developed models that predict negative effects of exchange rate changes to profitability. Jorion (1990) examined the relationship between the value of U.S. multinationals and the exchange rate of US multinationals. This association is called exchange rate exposure and found to be positively correlated with the degree of foreign involvement. Amihud (1994) couldn't confirm a statistically significant relationship between exchange rate changes and stock returns of US exporting firms. Similarly, Bailey and Chung (1995) found no evidence of conditional or unconditional risk premiums for exposure to changes in exchange rate and for the currency and political risks proxies. Bartov et al. (1996) suggested that the increased exchange rate variability increases the volatility of monthly stock returns for US multinational firms. Using a panel approach, Patro et al. (2002) in a panel framework concluded that the exchange rate risk exposure is significant for the stock market returns. Baggs et al. (2016) using Canadian firm-level annual data found that there is a significantly negative response of retailers' sales, employment and profits to currency appreciations.

It is important to note that the number of papers that take into account the economic uncertainty effect on profitability is limited since the literature have focused mainly on the investment – uncertainty relationship[38]. Demir (2009) examined the determinants of manufacturing firm profitability under uncertainty. His findings show that the effect of increased volatility on manufacturing profitability is significantly negative. The negative impact is reduced when the financial investments are increasing. Antonakakis et al. (2013) investigated the dynamic co-movements of stock market returns, implied volatility and policy uncertainty. They concluded that increased volatility of stock market and policy uncertainty affects negatively the stock market returns. The causal relationship between economic policy uncertainty and stock returns in China and India was studied by Li et al. (2016). By taking the

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[38] See Dixit and Pindyck (1994), Schwartz and Trigeorgis (2001), Panagiotidis and Printzis (2020), (2021)

structural changes into account they revealed bidirectional causal links showing negative impact of EPU changes on stock returns. Athari (2020) studied the Ukrainian bank system and suggested that the profitability of Ukrainian banks depends positively on domestic political stability and negatively on global economic policy uncertainty.

A broader picture of the literature on profitability and uncertainty relationship is given in Table 1. It summarizes several papers which examines the effects of exchange rate uncertainty and economic uncertainty on firm performance. It is worth mentioning that the vast majority of these studies suggest a negative impact of uncertainty on profitability and only few of them cannot confirm a statistical significant effect.

4.3 Empirical Specification

4.3.1 GMM estimation framework

We follow the estimation technique adopted in Panagiotidis and Printzis (2020). We apply a dynamic model which follows the form:

$$y_{it} = \alpha w_{it} + \beta x_{it} + c_i + u_{it} \quad (1)$$

where x_{it} is the vector of the strictly exogenous variables, w_{it} is the vector of the endogenous variables, c_i the unobserved group level effects, u_{it} the error term and α, β the coefficients to be estimated. The autoregressive terms are contained in the w_{it} vector.

We estimate the model by using the first-difference Arellano-Bond estimator introduced by Arellano and Bond (1991)[39]. This approach flexibly accommodates *"small T, large N"* panels and solves the inconsistency problem of the dynamic linear models. The model is estimated by applying the Windmeijer (2005) WC-robust two-step estimator to take into account the finite sample bias[40] and to overcome the issue of downward biased standard errors.

[39] Implemented in STATA 14 using Roodman (2007), (2009a).

[40]Windmeijer (2005) estimator provides Windmeijer-corrected standard errors that are robust to heteroscedasticity and serial correlation and they are adjusted for clustering at the firm level.

4.3.2 Panel Quantile Regression framework

We adopt an alternative framework to take into account the heterogeneity effects and the conditions of non-normality. Panel quantile regression was introduced by Koenker (2004). The technique used is similar to Panagiotidis and Printzis (2021) who examined the effects of uncertainty on investment. A dynamic model specification for the conditional quantile functions is given by:

$$Q_{y_{it}}(\tau|x_{it}) = c_i + y_{it-1}a(\tau) + x'_{it}\beta(\tau) \quad i = 1, \dots, N\,; \; t = 1, \dots, T \tag{2}$$

where $Q_{y_{it}}(\tau|x_{it})$ is the τth conditional quantile function of the response of the tth observation on the ith individual y_{it} , c_i is a fixed effect acting as a pure location shift independent of τ , $x'_{it}\beta(\tau)$ the covariates that depend upon the quantile τ and y_{it-1} the lag of the response variable. Panagiotidis and Printzis (2021) discusses the different approaches proposed in the literature to estimate (2). A GMM estimator with non-additive fixed effects which it is consistent for small T proposed by Powell (2014) is applied.[41].

4.3.3 Empirical model

We examine the performance of the Greek firms by applying the following profitability model:

$$\begin{aligned} PROF_{it} = \alpha_0 + \alpha_1 PROF_{it-1} + \alpha_2 L_{it-1} + \alpha_3 GS_{it-1} + \alpha_4 D_{it-1} + \alpha_5 SIZE_{it-1} + \alpha_6 MS_{it-1} \\ + \alpha_7 AGE_{it-1} + \beta h_{t-1} + c_i + u_{it} \end{aligned} \tag{3}$$

where $PROF$ is the profitability proxy (ROA is used as profitability proxy defined as the net profits before tax divided by the total assets), L the liquidity, GS the growth of sales ratio (growth of sales divided by total assets), D the debt ratio (bank liabilities divided by total assets), $SIZE$ the firm size proxy (natural logarithm of annual sales), MS the market share index (defined as the ratio of firms annual turnover divided by the aggregate annual sales), AGE the

[41] An advantage of this method is and that there is no need to specify fixed effects. The instruments are arbitrarily correlated with the non-additive fixed effects and when a lagged dependent variable is present consistent estimates for the dynamic case are also provided.

firms age, h_t the economic uncertainty, c_i the firm fixed effects, u_{it} the error term and a_0 the constant[42]. In the case of quantile regression (3) takes the form:

$$PROF_{it}(\tau) = \alpha_1(\tau)PROF_{it-1} + \alpha_{2(\tau)}L_{it-1} + \alpha_3(\tau)GS_{it-1} + \alpha_4(\tau)D_{it-1} + \alpha_5(\tau)SIZE_{it-1} + \alpha_6(\tau)MS_{it-1} + \alpha_7(\tau)AGE_{it-1} + \beta(\tau)h_{t-1} \quad (4)$$

Where $PROF_{it}(\tau)$ expresses the conditional distribution for any given $\tau \in (0,1)$. High (low) values indicate firms with relative strong (weak) profitability performance[43].

4.4 Data and Uncertainty proxy

4.4.1 Measuring Uncertainty

We employ the dynamic factor model of Panagiotidis and Printzis (2020) to estimate the common unobserved factor of several macroeconomic variables as a measure of economic uncertainty. The equations of the dynamic factor model are:

$$y_t = Af_t + Bx_t + u_t \quad (5)$$

$$f_t = Cw_t + D_1 f_{t-1} + D_2 f_{t-2} + \cdots + D_{t-p} f_{t-p} + \varepsilon_t \quad (6)$$

$$u_t = E_1 u_{t-1} + E_2 u_{t-2} + \cdots + E_{t-q} u_{t-q} + \nu_t \quad (7)$$

where y_t is the vector of k dependent variables, f_t the unobserved factors, and x_t the exogenous variables. Omitting the exogenous elements x_t and w_t [44]:

$$y_t = Af_t + u_t \quad (8)$$

$$f_t = D(L)f_{t-1} + \varepsilon_t \quad (9)$$

[42] In our specification, the rates of lagged investment, cash flow and growth of sales and the intrinsic uncertainty are treated as endogenous variables. The economic uncertainty is treated as strictly exogenous. Following Roodman (2007), (2009b) we make use of the "collapse" option in STATA to restrict the range of lags in the generation of the instruments sets. This way we deal with the problem of endogenous variables overfitting.

[43] We estimate the model by applying a two-step GMM method. The lagged regressors are used as instruments. The estimation follows the Markov Chain Monte Carlo (MCMC) optimization method.

[44] The model is estimated by maximum likelihood (ML) in a state-space form and using the Kalman filter. Results suggest the use of one factor. See Panagiotidis and Printzis (2020) for more details..

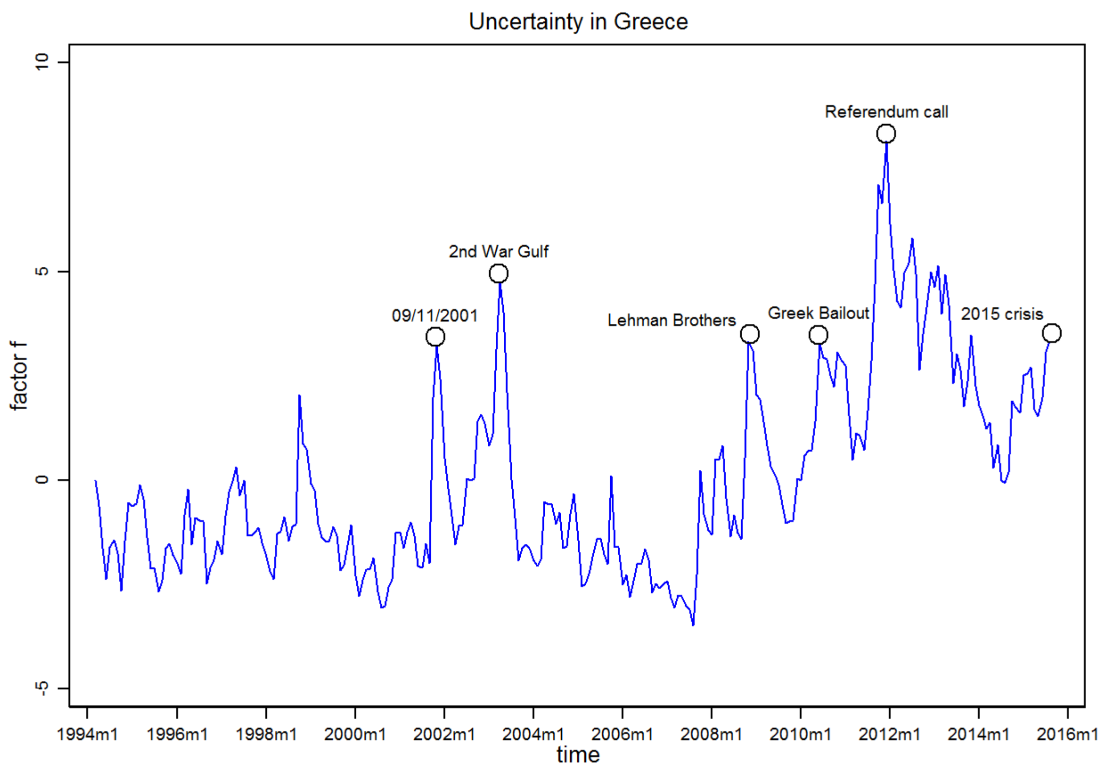
Table 1 presents the variables, their sources and the transformations of a set 9 economic indicators from 1994M01 to 2015M08. Figure 1 presents an illustration of the unobserved factor combined with the major economic events of this period. Both are reported in Panagiotidis and Printzis (2020).

Table 4.1: Macroeconomic variables and indices

	Variable	Abbreviation	Source	Transformation
Greek specific variables	Athens Stock Exchange closing prices	ASE	Athens Stock Exchange	(1− L)ln(Xt)
	Long-term Government Bond Yields	BONDS	Bank of Greece	(1− L)ln(Xt)
	Economic Sentiment Indicator	ESI	European Commission	(1− L)ln(Xt)
	Unemployment Rate	UNEMPL	Eurostat	(1− L)Xt
	Bank Interest Rate (Bank interest rates on new euro-denominated deposits and loans)	INTR	Bank of Greece	(1− L)ln(Xt)
	Industry Production Index (Total industry excluding construction)	IP	OECD	(1− L)ln(Xt)
	Loans to domestic private sector (Growth rate same period previous year)	LOANS	Bank of Greece	(1− L)Xt
Europe specific variable	Euro Area Business Climate Indicator	BCI	European Commission	Xt
	Economic Policy Uncertainty	EPU	Baker et al. (2015)*	Xt

Notes: *Xt* is the transformed variable and *L* is the lag-operator
*Data available on http://www.policyuncertainty.com/
The Economic Sentiment Indicator (ESI) and the Business Climate Indicator (BCI) are survey based indices conducted by the Directorate General for Economic and Financial Affairs (DG ECFIN). In Greece, the surveys are conducted by the Foundation of Economic & Industrial Research (FEIR/IOBE). See also (Panagiotidis and Printzis (2019)).

Figure 4.1: Uncertainty proxy



4.4.2 Firm-level Panel Data

The dataset includes the 25000 larger Greek firms with annual sales over 100000€ covering the period from 2000 to 2014 [45]. The main economic sectors of the Greek economy are covered: Agriculture, Fishing, Mining, Manufacturing, Construction, Trade, Hotels, Transport, Real Estate (without renting and business activities).

The following variables are constructed: Profitability (*PROF*) is the return on assets, equal to the net profits before tax divided by the total assets, capital stock (*K*) is the book value of total fixed assets, liquidity index (*L*) is the rate of current assets to short-term liabilities, growth of sales (*GS*) is the change in annual sales S divided by K, D the debt ratio (bank liabilities divided by total assets), $SIZE$ the firm size proxy (natural logarithm of annual sales), MS the market share index (defined as the ratio of firms annual turnover divided by the aggregate annual sales), AGE the firms age, (h_t) is the uncertainty proxy as estimated by the dynamic factor model. Data are trimmed at the 5th and 95th percentile to eliminate potential outliers. Firms with missing observations are omitted from the sample. Descriptive statistics are presented in Table 2.

Table 4.2: Descriptive Statistics

Variable	mean	sd	p5	p25	p50	p75	p95
$PROF$	0.30236	0.942466	-0.376212	-0.010843	0.0556575	0.26985	1.85152
L	1.53886	1.02916	0.59	0.98	1.24	1.72	3.56
GS	-0.024441	2.06925	-2.91683	-0.356757	0.0041777	0.358911	2.867
D	1.98599	2.9039	0.125277	0.467402	0.988654	2.11118	7.84504
$SIZE$	14.458	1.11774	12.5025	13.6738	14.5049	15.2879	16.2435
MS	0.209467	0.233998	0.0157849	0.0518369	0.123289	0.273646	0.729521
AGE	13.8582	7.62005	4	8	13	19	29
h_t	0.65084	2.25545	-2.30695	-1.67847	0.259116	3.23689	4.65384

Notes: Profitability (PROF):ROA, equal to the net profits before tax divided by the total assets
Growth of Sales (GS): Change is the annual turnover divided by fixed assets,
Liquidity (L): Rate of current assets to short-term liabilities
Debt ratio (D): Bank liabilities divided by total assets
Firm size (SIZE): Natural logarithm of annual sales
Market share index (MS): Ratio of annual sales to aggregate annual sales multiplied by 10^4
Age (AGE): Firms age
Economic Uncertainty (h_t): The common unobserved factor,
sd is the standard deviation and p5-p95 are the percentiles of the variables. The variables are trimmed at the 5st and 95th percentile to reduce the effect of outliers.

[45] Data obtained from Infobank Hellastat database (https://imentor.ibhs.gr/) .The Greek national statistical classification of economic activities, (STAKOD–03) follows the corresponding classifications of European Union (NACE Rev. 1.1) and United Nations (ISIC 3.1)

4.5 Results

4.5.1 GMM estimation framework

The results for the dynamic profitability model of (3) are presented in Table 3. Two different models are presented. The first one is a restricted version without the impact of the uncertainty factor while the second is the complete one. Both of the models confirm a positive lagged profitability effect providing evidence of a persistent behavior. There is a positive growth of sales effect and the variables of market share and age carry the expected positive sign. The contribution of the size variable is not statistically significant and the impact of leverage is found to be negative thus the profitability of the Greek firm is constrained by increased debt. The liquidity regressor reveals a statistically significant and negative impact on the profitability ratio. Although literature suggests in most cases a positive effect, this negative relationship supports a profitability-liquidity trade-off. The opportunity cost of holding assets than investing it may explain why an increase in firm liquidity may decrease the profitability level. The quantile regression analysis of the next section will cast more light on this issue. The effect of economic uncertainty is negative and statistically significant at the 1% level. According to the diagnostic tests of second-order autocorrelation and Sargan–Hansen J-test there is no auto-correlation in residuals and the instruments used are valid and exogenous.

Table 4.3: GMM Estimates of Profitability

Variable	Model1		Model2	
$(PROF)_{i.t-1}$	0.288***	(0.095)	0.271***	(0.101)
$(L)_{i.t-1}$	-0.900**	(0.364)	-0.912**	(0.382)
$(GS)_{i.t-1}$	0.075*	(0.044)	0.085*	(0.045)
$(D)_{i.t-1}$	-0.180***	(0.053)	-0.229***	(0.066)
$(SIZE)_{i.t-1}$	-0.068	(0.170)	-0.174	(0.145)
$(MS)_{i.t-1}$	2.389**	(1.068)	4.007***	(1.351)
$(AGE)_{i.t-1}$	0.056***	(0.021)	0.111***	(0.036)
h_{t-1}	-	-	-0.052***	(0.019)
Wald test (*p*-value)	0.000		0.000	
AR(2) test	0.750		0.830	
AR(2). *p*-value	0.454		0.406	
J (Sargan/Hansen) test	5.770		6.160	
J. *p*-value	0.567		0.723	
Number of Instruments	15		18	
Observations	54063		54063	

Notes: The models are estimated using the first-difference Arellano-Bond estimator developed by Arellano and Bond (1991) and implemented in STATA 14 by Roodman (2009a). Robust standard errors are reported in braces. Sargan–Hansen J-test is a test of overidentifying restrictions. AR (2) is the Arellano and Bond (1991) test for second order serial correlation. Robust standard errors are computed using the Windmeijer (2005) WC-robust two-step estimator. Instrument sets of the second through tenth lags of the right hand variables are used for the differenced equations. To avoid instrument proliferation we invoke the "collapse" option in order to restrict the lag ranges in the generation of the instruments sets. The *h* term is the measure of economic uncertainty. To eliminate the effect of outliers the data are screened by trimming observations at the 5th and 95th percentile. The following tests are applied: 1. Sargan-Hansen J-test as a test of overidentifying restrictions. 2. The difference-in-Hansen tests of exogeneity and validity of instrument subsets (not reported but available on request). 3. The Arellano and Bond (1991) test for second order serial correlation and 4. The Wald chi-squared statistic of the null hypothesis that all the coefficients except the constant are zero.
* significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level

4.5.2 Panel Quantile Regression

To capture potential heterogeneous effects we apply panel quantile regression analysis at aggregate level using the total sample, at firm size level according to firm size classification and at sectoral level following the Greek national classification of economic activities.

4.5.2.1 Aggregate level

Results are presented in Table 4 and Figure 2. A considerable heterogeneity effect exists for all the variables of the analysis. It is more than obvious that for different levels of economic performance of the Greek firm, as determined by the profitability ratio, the impact varies. Thus, firms of low profitability are negatively affected by economic uncertainty. On the other side, firms that belong to the upper quantiles of profitability rate are affected positively. It seems that a growth option mechanism may arise for firms with high ROA, The lagged profitability effect is positive and increases for the more profitable firms. The liquidity effect is positive for firms with lower ROA and turns negative for the firms above the 65th quantile. So, the profitability-liquidity trade-off and the opportunity cost of holding assets than investing may exist for the best performers in terms of profitability. The age and the size effect matters only for the lower and higher quantiles zone where takes positively and negative values, respectively. The market share effect is the only that follows an U-shape, however it remains positive across quantiles. The growth of sales impact decreases for the more profitable firms.

Figure 4.2: Total Sample

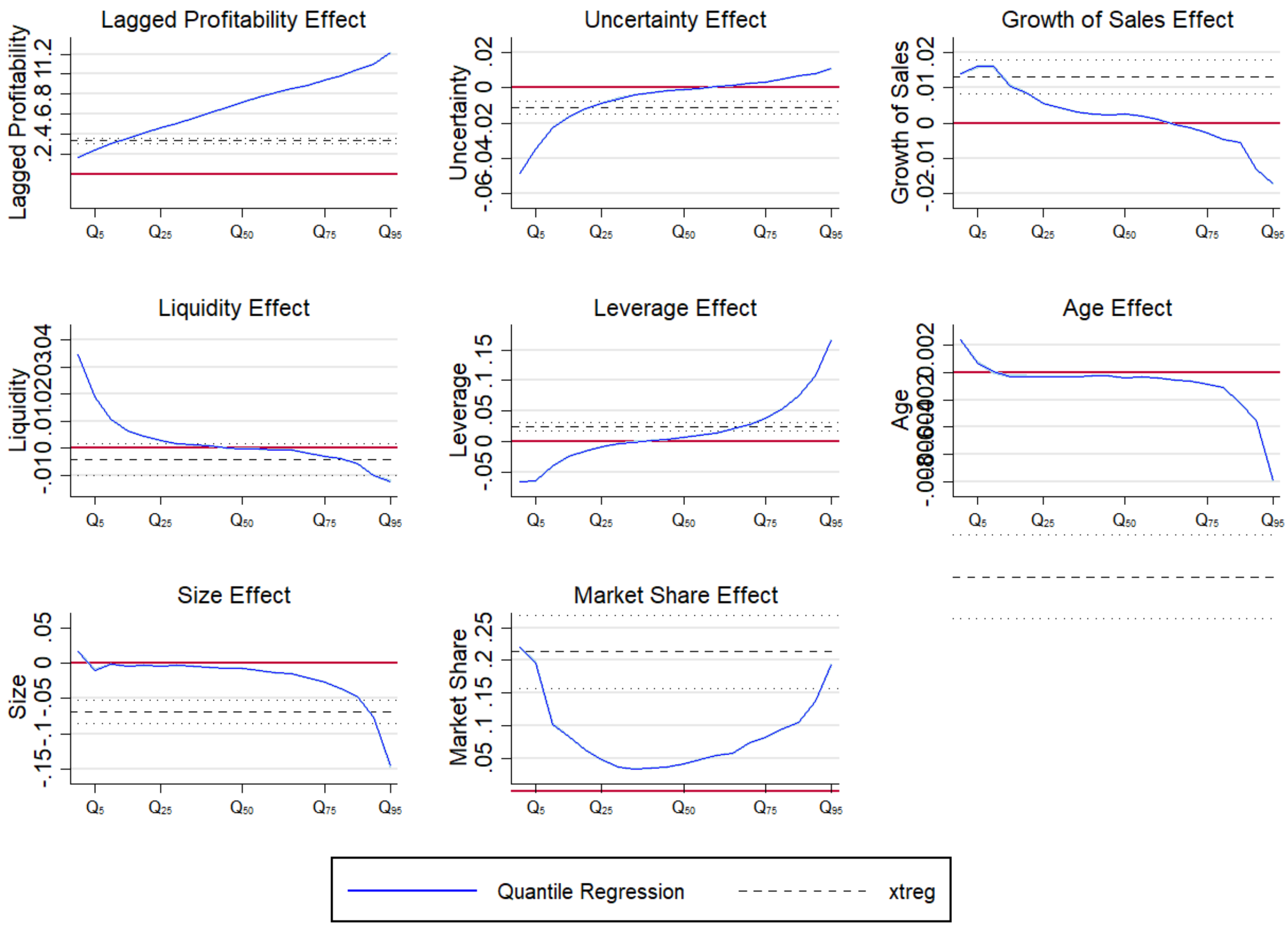


Table 4.4: Quantile Regression – Total sample

Variable	q1	q5	q10	q15	q20	q25	q30	q35	q40	q45
$(PROF)_{i.t-1}$	0.1700***	0.2432***	0.2988***	0.3585***	0.4058***	0.4617***	0.5092***	0.5643***	0.6138***	0.6622***
	(0.0000)	(0.0000)	(0.0001)	(0.0000)	(0.0001)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
h_{t-1}	-0.0483***	-0.0347***	-0.0231***	-0.0163***	-0.0112***	-0.0090***	-0.0061***	-0.0042***	-0.0022***	-0.0018***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
$(GS)_{i.t-1}$	0.0144***	0.0142***	0.0155***	0.0101***	0.0142***	0.0052***	0.0043***	0.0031***	0.0024***	0.0023***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0002)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
$(D)_{i.t-1}$	-0.0654***	-0.0643***	-0.0401***	-0.0248***	-0.0139***	-0.0090***	-0.0043***	-0.0010***	0.0016***	0.0039***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
$(L)_{i.t-1}$	0.0346***	0.0176***	0.0102***	0.0068***	0.0045***	0.0029***	0.0018***	0.0013***	0.0005***	0.0003***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
$(AGE)_{i.t-1}$	0.0022***	0.0008***	0.0003***	-0.0001***	-0.0010***	-0.0004***	-0.0003***	-0.0003***	-0.0003***	-0.0002***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
$(MS)_{i.t-1}$	0.2258***	0.1823***	0.1107***	0.0801***	0.1050***	0.0473***	0.0359***	0.0331***	0.0309***	0.0351***
	(0.0000)	(0.0001)	(0.0002)	(0.0000)	(0.0012)	(0.0001)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
$(SIZE)_{i.t-1}$	0.0176***	-0.0068***	-0.0037***	-0.0035***	-0.0098***	-0.0036***	-0.0028***	-0.0042***	-0.0043***	-0.0064***
	(0.0000)	(0.0000)	(0.0001)	(0.0000)	(0.0002)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Variable	q50	q55	q60	q65	q70	q75	q80	q85	q90	q95
$(PROF)_{i.t-1}$	0.7150***	0.7668***	0.8107***	0.8553***	0.8928***	0.9388***	0.9843***	1.0416***	1.1048***	1.2169***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
h_{t-1}	-0.0009***	-0.0003***	0.0004***	0.0015***	0.0024***	0.0032***	0.0057***	0.0070***	0.0088***	0.0104***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
$(GS)_{i.t-1}$	0.0024***	0.0020***	0.0011***	-0.0010***	-0.0013***	-0.0022***	-0.0043***	-0.0060***	-0.0123***	-0.0148***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
$(D)_{i.t-1}$	0.0064***	0.0101***	0.0142***	0.0198***	0.0282***	0.0382***	0.0538***	0.0741***	0.1073***	0.1657***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
$(L)_{i.t-1}$	0.0006***	-0.0002***	-0.0005***	-0.0014***	-0.0018***	-0.0037***	-0.0065***	-0.0064***	-0.0120***	-0.0144***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
$(AGE)_{i.t-1}$	-0.0003***	-0.0003***	-0.0004***	-0.0005***	-0.0007***	-0.0010***	-0.0015***	-0.0019***	-0.0037***	-0.0074***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
$(MS)_{i.t-1}$	0.0425***	0.0474***	0.0553***	0.0558***	0.0756***	0.0806***	0.0916***	0.1126***	0.1373***	0.2017***
	(0.0001)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
$(SIZE)_{i.t-1}$	-0.0084***	-0.0103***	-0.0134***	-0.0150***	-0.0218***	-0.0274***	-0.0342***	-0.0507***	-0.0783***	-0.1508***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Observations	71630	71630	71630	71630	71630	71630	71630	71630	71630	71630
Firms	13547	13547	13547	13547	13547	13547	13547	13547	13547	13547

Notes: The model is estimated using a two-step GMM method developed by Powell (2014) and implemented in STATA 14. The estimation is based on the Markov Chain Monte Carlo (MCMC) optimization method. Robust standard errors are reported in braces. The h term is the measure of economic uncertainty. Current values of h_{t-1} and one-period lagged values for the rest of the regressors are used as instruments. To eliminate the effect of outliers the data are screened by trimming observations at the 5st and 95th percentile.

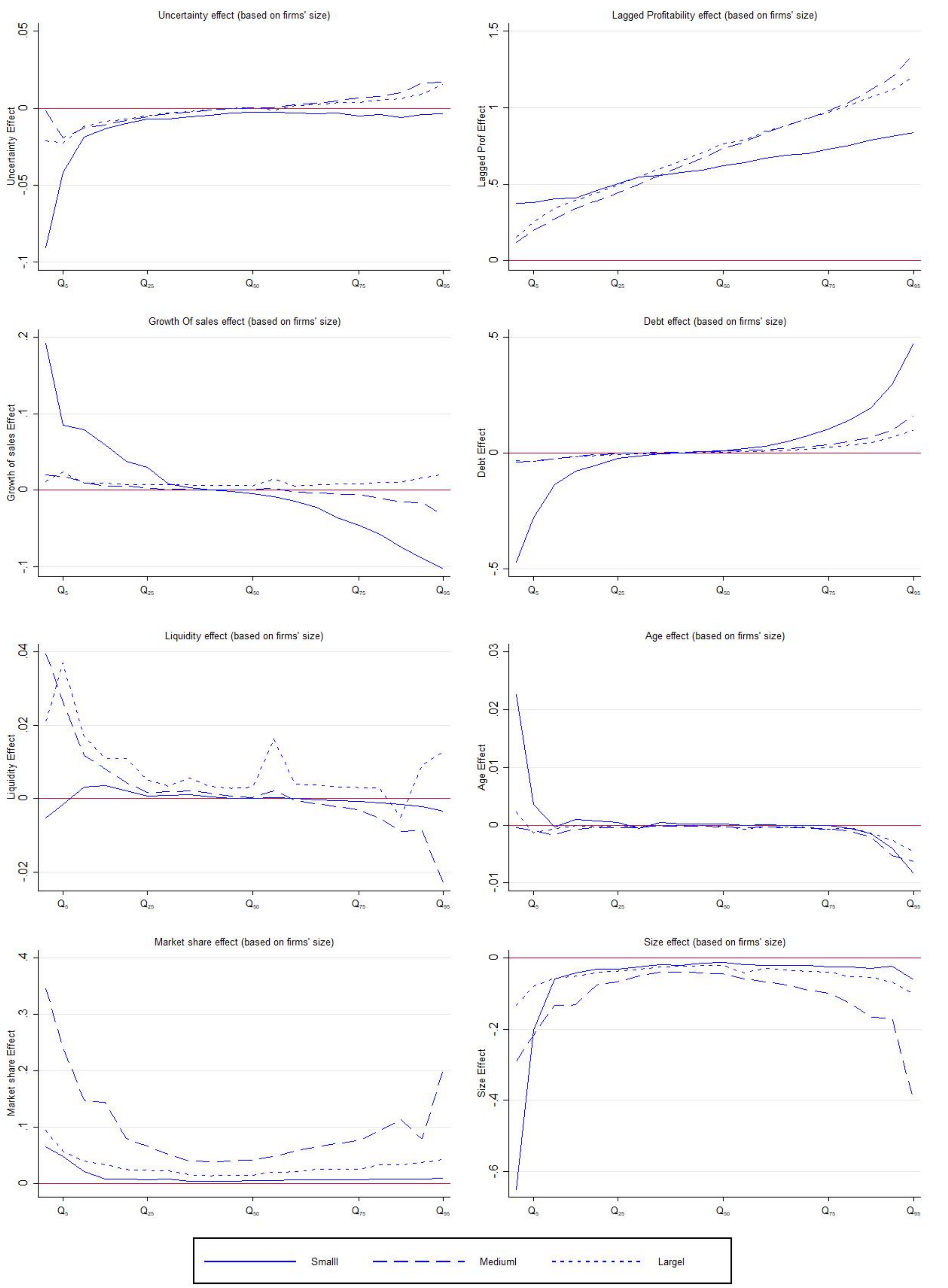
* significant at the 5% level; ** significant at the 1% level; *** significant at the 0.1% level

4.5.2.2 Firm size level

We classify firms in three clusters based on the annual turnover percentile ranking. Firms below the 25th percentile (p25) are denoted small, between the 25th and the 75th are denoted medium and above the 75th percentile (p75) are the large firms. Figure 3 presents the variables effects for each rank. At first sight there is a notable heterogeneity in performance between firms of the three categories. The uncertainty effect is negative for the smaller firms and particularly strong for the lower quantiles. This means that firms with low ROA and low turnover are the more exposed. On the other hand large and medium firms with high profitability ratios accept positive effects when uncertainty changes. The disaggregate analysis at firms size level show that in the case of firms with medium or large turnover and high profits a mechanism similar to growth option[46] may be activated. The environment of increased uncertainty seems to be fruitful for firms of these categories. The lagged profitability impact is more profound for the medium and large firms that belong to the upper quantiles. The growth of sales vary across quantiles and the debt effect changes sign above the median. This finding is remarkable for the Greek firm, It indicates that the profitability of firms with higher profits is affected positively by debt while low performers in terms of profit face negative debt impact. The firm size and liquidity effects are mixed. The market share impact remains positive for all the quantiles while the size effect is always negative. This is in line with the dynamic GMM model results (although, statistically insignificant) but it is contradictory with the general belief that the bigger the player in the market the better it performs. Regarding the age effect it seems that only firms with very low or very high profits are those that are essentially affected by the years of establishment.

[46] See Dixit and Pindyck (1994) for growth option mechanism in uncertainty-investment literature.

Figure 4.3: Classification



4.5.2.3 Sectoral level

We apply our empirical model to the main sectors of economic activity in Greece to capture potential sectoral variation. Sectors include Manufacturing, Agriculture, Education, Fishing, Mining, Real Estate, Trading and Transportation. The results are summarized in the combined graphs of Figure 4. With the exception of the lagged profitability effect all the explanatory variables of the model have a stronger impact on profitability for the lower and the higher quantiles of the distribution. Regarding uncertainty, which is our main focus, there is a strong heterogeneity for the first quantiles (Q1-Q20) . Education and Fishing are the most negatively affected and the Agriculture sector is affected positively. Above the median the Real Estate sector is facing the greatest profitability losses. It is interesting to note that lagged profitability is the most heterogeneous variable. It indicates that past profitability behavior doesn't affect future performance in the same magnitude for each sector. To sum up, heterogeneity exists among sectors but largely for the first and for the last quantiles of the profitability distribution.

4.6 Robustness Analysis

For the Greek case the panel quantile regression approach seems to be more appropriate to investigate the effects of uncertainty on profitability rate, versus to the simplified approach of the conditional mean. We justify it because of the sharp differences and the changes of sign among the quantiles of the distribution showing that we expect different results depending on the profitability performance of the Greek firm. We check the robustness of this model by introducing two additional interaction terms between uncertainty, debt and liquidity. These new terms act as alternative channels of transmission of the volatility effect. The findings are presented in Table 5 and Figure 4.

Figure 4.4: Sectors

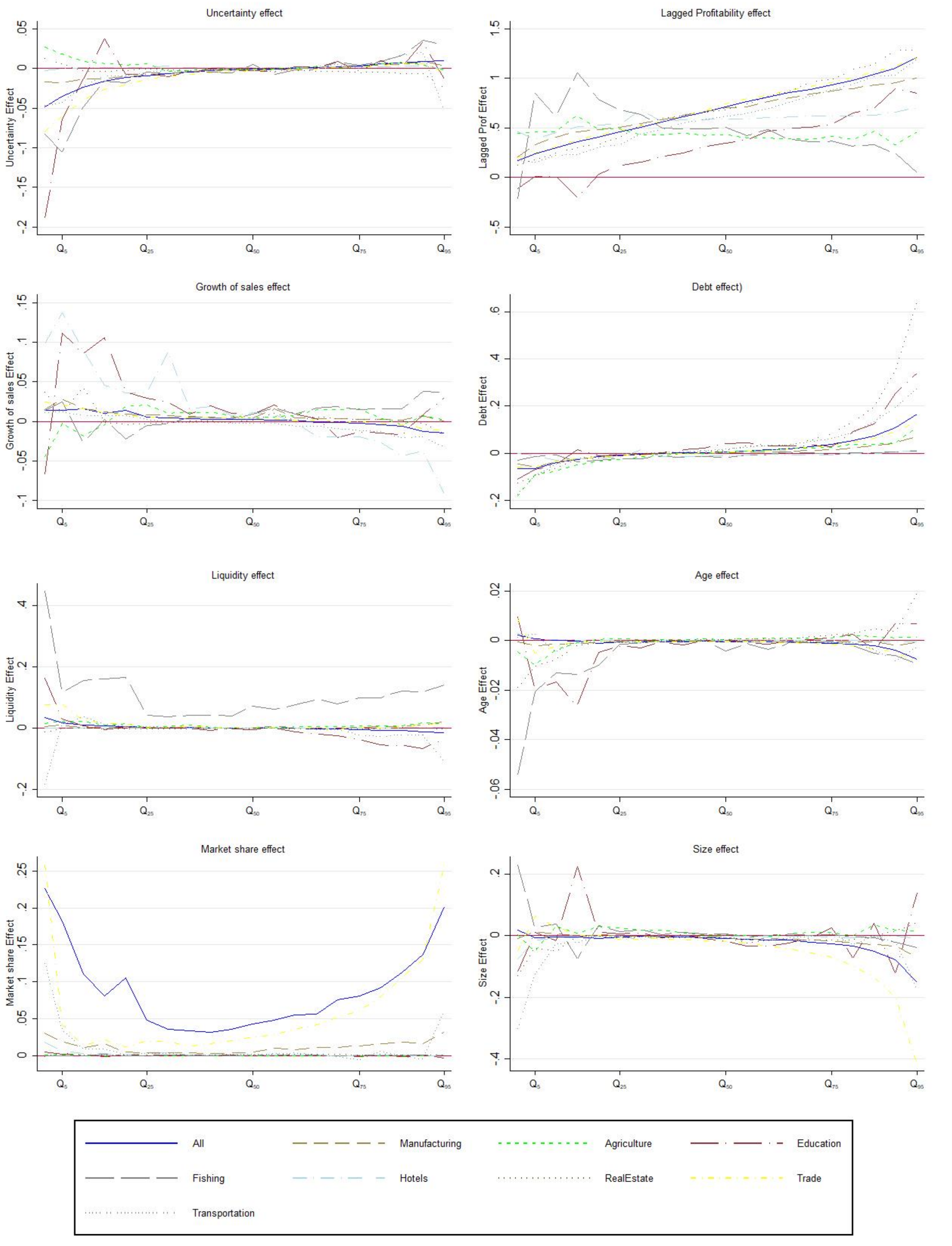


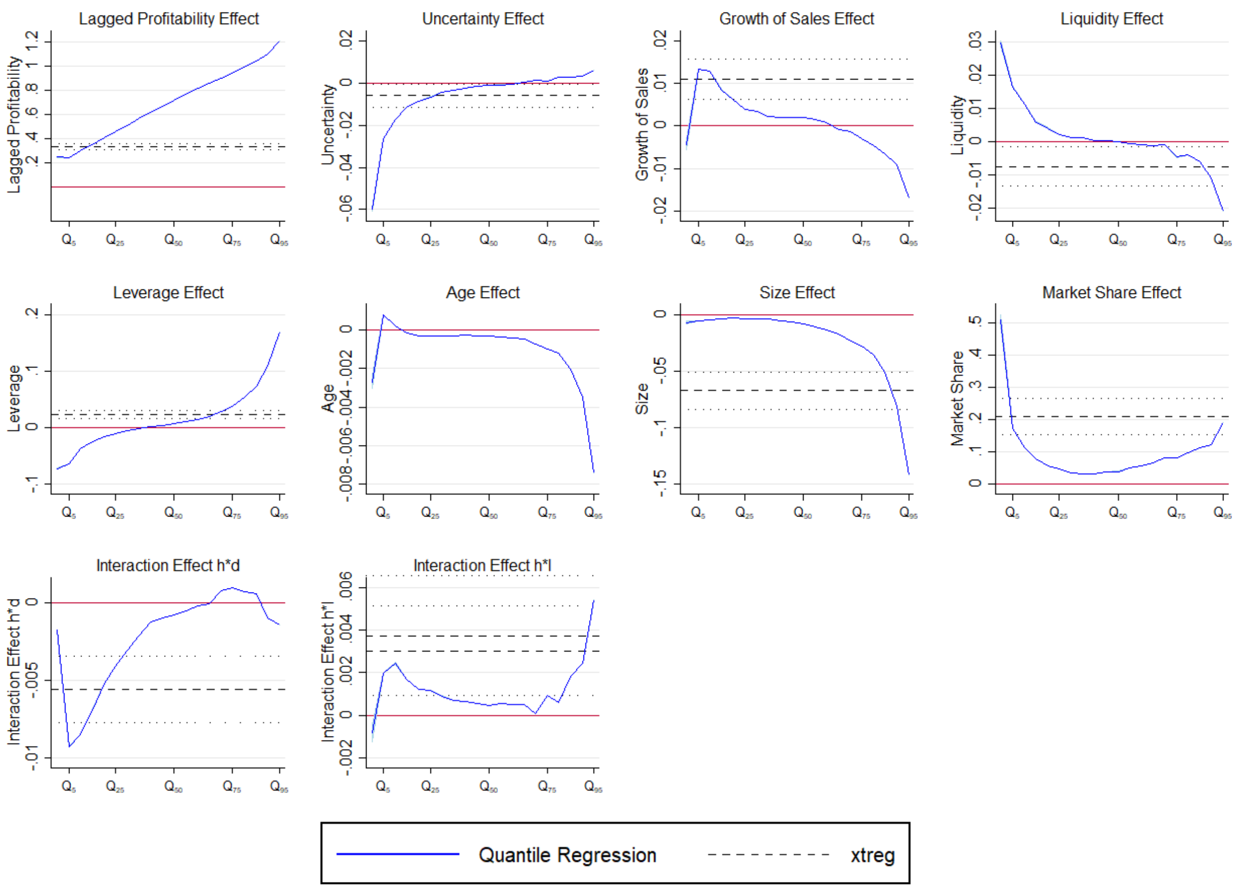
Table 4.5: Robustness check – Interaction Effects

Variable	q1	q5	q10	q15	q20	q25	q30	q35	q40	q45
$(PROF)_{i.t-1}$	0.2452***	0.2411***	0.2962***	0.3507***	0.4058***	0.4590***	0.5072***	0.5624***	0.6126***	0.6606***
	(0.0028)	(0.0001)	(0.0000)	(0.0000)	(0.0001)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
h_{t-1}	-0.0599***	-0.0262***	-0.0173***	-0.0113***	-0.0085***	-0.0064***	-0.0044***	-0.0031***	-0.0024***	-0.0015***
	(0.0004)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
$(GS)_{i.t-1}$	-0.0044***	0.0135***	0.0129***	0.0085***	0.0063***	0.0039***	0.0034***	0.0023***	0.0020***	0.0021***
	(0.0006)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
$(D)_{i.t-1}$	-0.0722***	-0.0635***	-0.0382***	-0.0246***	-0.0156***	-0.0100***	-0.0053***	-0.0020***	0.0016***	0.0039***
	(0.0003)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
$(L)_{i.t-1}$	0.0294***	0.0164***	0.0111***	0.0058***	0.0041***	0.0022***	0.0011***	0.0011***	0.0003***	0.0003***
	(0.0003)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
$(AGE)_{i.t-1}$	-0.0027***	0.0008***	0.0002***	-0.0001***	-0.0003***	-0.0003***	-0.0003***	-0.0003***	-0.0003***	-0.0003***
	(0.0002)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
$(MS)_{i.t-1}$	0.5104***	0.1724***	0.1122***	0.0792***	0.0575***	0.0483***	0.0355***	0.0305***	0.0322***	0.0368***
	(0.0084)	(0.0001)	(0.0003)	(0.0000)	(0.0001)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
$(SIZE)_{i.t-1}$	-0.0071***	-0.0058***	-0.0045***	-0.0036***	-0.0031***	-0.0040***	-0.0034***	-0.0037***	-0.0051***	-0.0065***
	(0.0006)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
$(h*D)_{i.t-1}$	-0.0018***	-0.0093***	-0.0085***	-0.0069***	-0.0052***	-0.0041***	-0.0031***	-0.0021***	-0.0013***	-0.0010***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
$(h*L)_{i.t-1}$	-0.0008***	0.0020***	0.0024***	0.0017***	0.0012***	0.0012***	0.0009***	0.0007***	0.0006***	0.0005***
	(0.0002)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Variable	q50	q55	q60	q65	q70	q75	q80	q85	q90	q95
$(PROF)_{i.t-1}$	0.7140***	0.7655***	0.8106***	0.8552***	0.8929***	0.9402***	0.9874***	1.0397***	1.1003***	1.2021***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
h_{t-1}	-0.0009***	-0.0007***	-0.0003***	0.0005***	0.0015***	0.0011***	0.0030***	0.0028***	0.0034***	0.0063***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
$(GS)_{i.t-1}$	0.0021***	0.0017***	0.0009***	-0.0008***	-0.0014***	-0.0031***	-0.0046***	-0.0066***	-0.0092***	-0.0170***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
$(D)_{i.t-1}$	0.0065***	0.0101***	0.0142***	0.0200***	0.0284***	0.0378***	0.0529***	0.0739***	0.1080***	0.1686***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
$(L)_{i.t-1}$	0.0001***	-0.0006***	-0.0008***	-0.0012***	-0.0008***	-0.0046***	-0.0038***	-0.0059***	-0.0107***	-0.0207***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
$(AGE)_{i.t-1}$	-0.0003***	-0.0004***	-0.0004***	-0.0005***	-0.0007***	-0.0010***	-0.0012***	-0.0020***	-0.0035***	-0.0074***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
$(MS)_{i.t-1}$	0.0394***	0.0490***	0.0555***	0.0649***	0.0808***	0.0827***	0.0981***	0.1142***	0.1213***	0.1906***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
$(SIZE)_{i.t-1}$	-0.0079***	-0.0106***	-0.0134***	-0.0171***	-0.0233***	-0.0276***	-0.0361***	-0.0514***	-0.0810***	-0.1416***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
$(h*D)_{i.t-1}$	-0.0008***	-0.0005***	-0.0002***	-0.0001***	0.0008***	0.0009***	0.0007***	0.0006***	-0.0010***	-0.0015***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
$(h*L)_{i.t-1}$	0.0004***	0.0005***	0.0005***	0.0005***	0.0001***	0.0009***	0.0006***	0.0018***	0.0024***	0.0054***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Observations	71630	71630	71630	71630	71630	71630	71630	71630	71630	71630
Firms	13547	13547	13547	13547	13547	13547	13547	13547	13547	13547

Notes: The model is estimated using a two-step GMM method developed by Powell (2014) and implemented in STATA 14. The estimation is based on the Markov Chain Monte Carlo (MCMC) optimization method. Robust standard errors are reported in braces. The h term is the measure of economic uncertainty. Current values of h_{t-1} and one-period lagged values for the rest of the regressors are used as instruments. To eliminate the effect of outliers the data are screened by trimming observations at the 5st and 95th percentile.

* significant at the 5% level; ** significant at the 1% level; *** significant at the 0.1% level

Figure 4.5: Robustness check – Interaction terms



The transmission mechanism of the volatility effect through the debt channel is negative. The interpretation is that in conditions of increased uncertainty the profitability response on leverage decreases or that the effect of debt under uncertainty is more weak. The interaction effect of the liquidity channel is at the opposite side. When uncertainty increases liquidity plays an additional positive role. Furthermore, the original specification of model (4) is confirmed by the results of the robustness augmented model since the coefficients of the profitability determinants continue to have qualitatively similar results.

To further check the robustness of the model we apply the Machado and Santos Silva (2019) estimator and a pooled quantile regression estimator. The results are presented in Figures 5 & 6. The strong assumptions of strict exogeneity, of no serial correlation and of low n/T ratio (our dataset n/T ratio is high) may be the reasons that the Machado and Silva model doesn't match the results of the original approach with the exception of uncertainty and lagged profitability determinants. The pooled quantile regression estimator verifies the robustness of the main findings.

Figure 4.6: Robustness check – Machado and Santos Silva (2019)

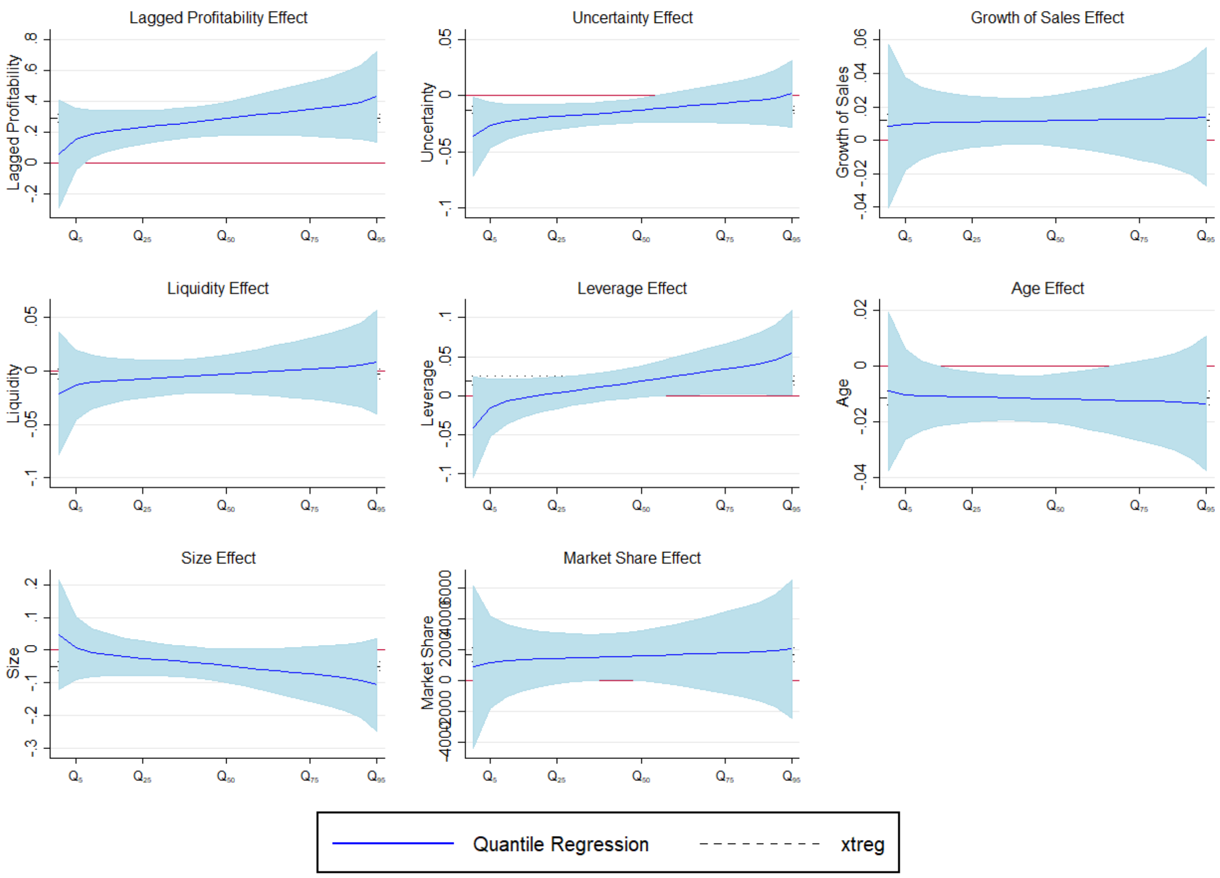
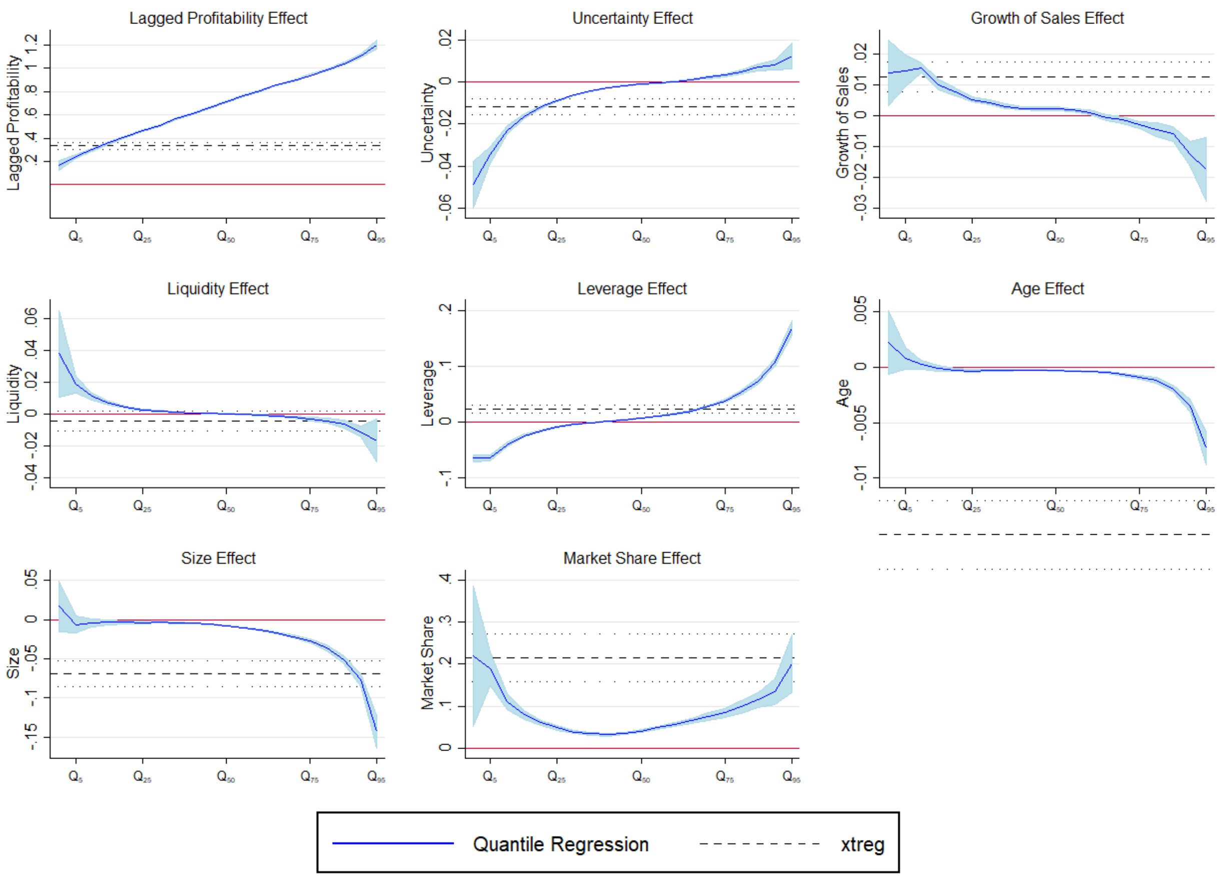


Figure 4.7: Robustness check – Pooled Quantile Estimation



4.7 Conclusions

We examined the effect of uncertainty as an additional determinant of profitability in Greece. The period under investigation included the years of prosperity as well as the years of financial crisis. The study utilized a large panel dataset of Greek firms of different economic sectors and of different sizes. We find a significant decrease in profitability rate following the onset of increased economic uncertainty. This result is suggested by both models, GMM dynamic model and panel quantile regression model. Next, we classified our sample in three clusters based on the annual turnover percentile ranking. Results revealed heterogeneous effects. The essential point is that smaller firms are exposed to the uncertainty impact while large and medium firms with high profitability ratios react positively. We extended the scope of the paper to the sectoral level and we found profitability heterogeneities for the first and for the last quantiles of the profitability distribution. A number of further analyses confirmed the robustness of the model.

This paper contributes to the empirical literature in two ways. The first is that it includes the uncertainty effect in the determinants group. The second is that it applies a panel quantile model to gauge this effect. One might suspect a negative sign for the uncertainty impact on profitability. This is far from certain, however. Our investigation shows that this negative sign is not always negative or of a similar magnitude. It depends on the firms size and on the economic sector. This result has important implications for policymakers or regulatory authorities. In order to build or to recover an environment of economic stability they shouldn’t develop similar practices for all economic sectors or for all firm sizes. Otherwise, they should expect size-variant and sector-variant responses.

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4.9 Appendix

Table 4.6: Profitability & Uncertainty - Literature review

	Title	Authors	Data	Methodology	Conclusions
1	R&D profitability: the role of risk and Knightian uncertainty	Amoroso et al. (2015)	Economic and financial panel data of the top 2000 world R&D investors covering the period 2004-2012. The variables include cash investment, net sales, operating profits, capital expenditure, number of employees, and market capitalization. Two proxies of uncertainty are taken: A firm level indicator based on 'entrepreneur's forecast error' and the Uncertainty Avoidance Indicator (UAI) as a country-level one. Risk is measured by the variance of losses	In the empirical specification operation profits are regressed on their own lagged values, on R&D investment, physical capital, risk and on uncertainty proxies.	There is a significant negative impact of firm-level and country-level uncertainty on operating profits.
2	Exchange Rate Fluctuations , Political Risk , and Stock Returns : Some Evidence from an Emerging Market	Bailey and Chung (1995)	Data include closing stock prices for Mexico from January 1986 to June 1994. Four economic risk factors are used:. RFX (percent change in the official pesos per U.S. dollar foreign exchange rate), PREM (monthly change in the free market premium for dollars), DCREDIT (monthly return spread between a dollar bond issued by the Mexican government and a matched maturity U.S. Treasury note) and RMKT (monthly log-change in the IPC stock index in excess of the riskless CETES yield)	The paper explores the impact of cross –sectional differences in exposures to exchange rate fluctuations and political risk on stock prices. Several regressions are estimated (Regression of stock portfolio returns on the economic risk factors, a model of Time-Varying Risk Exposures, a multistage estimates model etc)	There is no evidence of conditional or unconditional risk premiums for exposure to changes in exchange rate and for the currency and political risks proxies. Some evidence of time-varying equity market premiums for exposure to changes in the dollar premium and sovereign default risk is found.
3	Profitability , Uncertainty , and Firm Size	Ballantine et al. (1993)	CSB-SOI data for 1975 and 1979 are used to construct measures of profitability, asset intensity, debt and advertising intensity.	The empirical approach examines the means for the several variables to distinguish between small and large firms' performance and within industry regression analyses for each industry division.	Increased uncertainty (as expressed by wide ranges between loss and profit rates) increases profit rates.
4	Firm Valuation, Earnings Expectations, and the Exchange-Rate Exposure Effect	Bartov and Bodnar (1994)	The sample spans from 1978 to 1989 and contains 208 distinct US industrial firms and 2264 firm-quarter observations. Data include common equity market value, annual sales, ratio of annual earnings per share to stock price and annual dividend yield.	A single regression model of abnormal stock returns against a set of current and lagged changes in the foreign currency value of the U.S. dollar and a constant is employed.	Exchange rate volatility provide little explanation for stock returns of the sample firms. There is a negative association between a lagged change in the dollar and abnormal stock returns
5	Exchange rate variability and the riskiness of U.S. multinational firms: Evidence from the breakdown of the Bretton Woods system	Bartov et al. (1996)	The sample contains data for 109 US multinational firms over two 5-year windows (1966-1970 & 1973-1977). Statistics computed are common equity market value, annual sales, total assets, ratio of annual earnings per share to stock price and debt equity ratio.	To examine the impact of the exchange variability on market risk a single factor market model is used. An augmented model is also employed for sensitivity analysis purposes.	Increased exchange rate variability increases the volatility of monthly stock returns for US multinational firms.
6	Impact of Macroeconomic Uncertainty on Firm Profitability : A Case of Bist Non- Metallic Mineral Products Sector	Bayar and Ceylan (2017)	Panel data of 23 publicly traded cement firms covering the period 2003:Q1-2016Q4. Variables include ROA, ROAF, Leverage, Exchange rate, Interest Rates, CPI, GDP.	Two regression models are employed to gauge the volatility effects on ROA (Returns on Assets) and ROAF (Returns on Operating Profits). (GARCH) models are applied to estimate the volatility of exchange rate, interest rate, inflation rate and growth rate.	With the exception of inflation volatility the effect of the variables on profitability is negative. The impact of growth volatility is the highest while the impact of exchange rate is the lowest.
7	Firm Profitability, Inventory Volatility, and Capital Structure	Birge and Xu (2011)	Compustat data over the period 1995-2006 for profitability as measured by EBIT divided by Sales, ratio of earnings to sales, leverage ratio, sales, inventory.	A trade off model that captures operational and leverage decisions is used.	There is a decreasing inventory volatility for non-profitable firms and an increasing inventory volatility for profitable firm.
8	Financialization and Manufacturing Firm Profitability under Uncertainty and Macroeconomic Volatility: Evidence from an Emerging Market	Demir (2009)	Semi-annual data from 1993:1 to 2003:2 for publicly traded manufacturing firms in Turkey. publicly traded manufacturing firms Variables include net fixed assets, profitability rates, sales, capital output. Manufacturing inflation, interest rate and capital flow volatility are used to estimate uncertainty	AR(1) process and GARCH models are the two alternative methods applied on a vector of external shock and uncertainty variables in order to proxy uncertainty. A dynamic panel model is estimated using an augmented system GMM	The effect of increased volatility on manufacturing profitability is significantly negative. The negative impact is reduced when the financial investments are increasing.

	Title	Authors	Data	Methodology	Conclusions
				technique by Arellano & Bover (1995) and Blundell and Bond (1998)	
9	The Exchange-Rate Exposure of U.S. Multinationals	Jorion (1990)	Rate of return on US firms' common stocks starting in 1971:1 and ending in 1987:12. The rate of change in exchange rate, is measured as the dollar price of the foreign currency. The rate of return on the CRSP value-weighted market index is also considered.	Changes in the value of firm are regressed on the exchange rate change.	The exchange rate exposure is correlated with the degree of foreign involvement. Without this the exposure doesn't differ across domestic firms.
10	Exchange Rate Volatility and Corporate Performance in Nigeria: a Panel Regression Approach	Kelilume and Salami (2012)	A balanced panel for 20 firms over the 2004-2013 period. Variables used to assess the corporate performance are the asset turn ratio, the rate of return on assets and the portfolio activity & resilience.	A dynamic panel regression model is used to examine the effect of exchange rate volatility on the firm's performance. Crude Oil Price, Prime Lending Rate Imports as a % of GDP, Reserves and Total Government Expenditure are the control variables of the model. The model is estimated by the Arrelano - Bond & Arellano-Bover GMM methods.	Results show that the impact of exchange rate volatility on the corporate performance in Nigeria is significantly negative.
11	Inter-Industry Profitability under Uncertainty	Litzenberger and Joy (2007)	Rates for returns for a sample of 136 industrial firms over 19520-1967 period. Risk is measured by the standard deviation of returns rate.	A two- way ANOVA method is used to find differences in risk-adjusted inter-industry profitability rates.	The differences in risk-adjusted inter-industry profitability rates were found to be significant and persistent.
12	Exchange Rates and Profit Margins: The Case of Japanese Exporters	Klitgaard (1999)	Sample covers the period from January 1981 to June 1997. The variables set includes yen price of exports, price of goods sold in Japan, exchange rate, price index, production cost and income.	A Marston model of profit maximization is used to examine the long-run response of profit margins to changes in yen. Dynamic ordinary least squares Regressions are applied.	A 10 percent rise in the yen leads to 4 percent decline in export profit margins. The transportation equipment and electrical machinery industries face stronger short-run responses of profit margins to exchange rate movements.
13	Is Foreign Exchange Risk Priced in the Japanese Stock Market?	Choi et al. (1998)	Monthly Japanese industry firms portfolio returns, exchange rates, and risk factors for the period January 1974 to December 1995.	An unconditional and a conditional multi- factor asset pricing model is used to gauge the role of exchange risk in Japanese stock market.	Results show that exchange risk is priced in Japan, in general terms. When a trade-weighted exchange rate is used the results become more mixed compared to the bilateral yen/US dollar rate measure.
14	The pricing of currency risk in Japan	Doukas et al. (1999)	Monthly stock returns data for 1079 Japanese firms from January 1975 to December 1995.	A multifactor asset pricing model is applied and estimated by a INSURE procedure.	The foreign exchange rate risk premium is significant for the Japanese firms' stock returns.
15	Explaining exchange rate risk in world stock markets: A panel approach	Patro et al. (2002)	Panel data with weekly observations of equity index prices for 16 countries from January 1980 to December 1997.	A time-varying two-factor international asset pricing model is estimated following the GARCH methodology.	The exchange rate risk exposure is found to be significant for the stock market returns. Currency risk exposure depends on exports, credit rating and taxes.
16	The World Price of Foreign Exchange Risk	Dumas and Solnik (1995)	Excess returns on equity market, one month interest rate and exchange risk premia for Germany, UK, USA, Japan from January 1970 to December 1991	The study is based on a "international" conditional asset pricing model.	Foreign exchange rate risk is priced and it is found to be a significant component of rates of return.
17	Firm Dynamics in Retail Trade: The Response of Canadian Retailers to Exchange Rate Shocks	Baggs et al. (2016)	Canadian firm-level annual data for the period 1986-1997. Data cover several firms' characteristics (sales, profits, assets, number of employees etc)	The empirical specification estimates the relationship between real exchange rate movements and firm characteristics in a panel fixed effects regression framework.	There is a significantly negative response of retailers' sales, employment and profits to currency appreciations.

	Title	Authors	Data	Methodology	Conclusions
18	The Causal Relationship Between Economic Policy Uncertainty and Stock Returns in China and India: Evidence from a Bootstrap Rolling Window Approach	Li et al. (2016)	Monthly EPU indices and stock returns for China from 1995:02 to 2013:02 and for India from 2003:02 to 2013:02.	In a bivariate VAR framework, Granger con causality tests are applied. A residual-based bootstrap (RB) modified-LR statistic is employed to examine the causal relationship between EPU and stock returns. Structural changes are taken into account by performing sub-sample rolling-window causality tests.	When full- sample causality tests are applied a causal relationship between EPU and stock returns is not found. By taking the structural changes into account there is evidence of bidirectional causal links showing negative impact of EPU changes on stock returns.
19	Effects of Exchange Rate Volatility on the Stock Market: A Case Study of South Africa	Mlambo et al. (2013)	Monthly data for South Africa from 2000 to 2010. Variables include stock market capitalization, exchange rate volatility, interest rate, US interest rates, total mining production and exports.	A GARCH model was estimated to examine the effects of exchange rate volatility on the South Africa stock market performance.	The relationship between exchange rate volatility and stock market was found to be very weak.
20	The impact of exchange rate movements on firm value in emerging markets: The case of Mexico	Flota (2014)	Stock market return data, sales, total assets, liabilities for Mexican non-financial firms over the 1994-2003 period.	A two-stage regression model was applied. In the first stage cross-sectional differences in exposures to exchange rates fluctuations were examined. The determinants of exposure are examined in the second stage.	There is a significant firms' exposure to exchange rate fluctuations. The second stage regressions suggest that firms with international activities are less sensitive to exchange rate volatility compared to firms that rely on domestic sales.
21	Dynamic co-movements of stock market returns, implied volatility and policy uncertainty	Antonakakis et al. (2013)	Implied volatility index of S&P500 (VIX), Policy uncertainty index of Baker et al. (2015) and the S&P500 returns for the period January 1985 to January 2013.	A dynamic conditional correlation (DCC) model is used to examine the correlations among stock market returns, policy uncertainty and implied volatility.	Increased volatility of stock market and policy uncertainty affects negatively the stock market returns. With the exception of the latest financial crisis the dynamic correlation between stock market returns and policy uncertainty appear to be negative over time.
22	Exchange rate volatility and stock returns for the U.S	Sekmen (2011)	US stock returns (computed by S&P500) and exchange rates for the period 1980 to 2008.	Squared residuals of an AR(1) process are used to estimate exchange rate volatility. OLS is used to examine the effect of volatility on US stock returns.	Exchange rate volatility affects negatively US stock returns.
23	A GARCH Examination of Macroeconomic Effects on U.S. Stock Market: A Distinction Between the Total Market Index and the Sustainability Index	Sariannidis et al. (2010)	Monthly data for DJSI, DJW 5000, 10 years Bond, Yen/US dollar exchange rate and non-farm payrolls for USA over the period February 1999 to January 2008.	A GARCH model is used to empirically examine the effect of macroeconomic volatilities on US stock market	Exchange rate fluctuations and crude oil changes have a negative effect on US stock returns. Changes in 10-year bonds' returns have a positive effect.
24	Effect of Exchange Rate Volatility on the Ghana Stock Exchange	Adjasi et al. (2008)	IMF data on stock market returns, money supply, treasury bill rate, trade deficit, CPI, exchange rates from March 1995 to June 2006.	An EGARCH model is applied to examine the relationship between stock market and exchange rate volatilities.	The relationship is found to be significantly negative. Any depreciation of the local currency may lead to stock market appreciation.
25	Exchange rates and stock prices: A study of the US capital markets under floating exchange rates	Aggarwal (1981)	NYSE, S&P500, DC500 stock price indices and US dollar rate for the period July 1974 to December 1978	Regressions between stock price indices and US dollar value.	There is a positive correlation between stock prices and exchange rate.
26	Excess Returns to R&D-Intensive Firms	Chambers et al. (2002)	Annual R&D, sales and assets data for 13442 Compustat firms from 1979 to 1998.	Several regressions of excess returns on R&D changes and levels are performed.	R&D intensive firms with high R&D/sales and R&D/assets ratios earn high excess returns. Results support the risk-bearing hypothesis.
27	The Stock Market Valuation of Research and Development Expenditures	Chan et al. (2001)	R&D and stock returns data for domestic firms listed in AMEX, NYSE and Nasdaq for the period 1975-1995.	Descriptive analyses are presented for alternative portfolio classifications. A risk-adjustment procedure is followed by estimating time-series regression of a factor model.	R&D intensive firms earn large excess returns. There is a positive association between R&D intensity and return volatility.

	Title	Authors	Data	Methodology	Conclusions
28	Exchange Rates and the Valuation of Equity Shares	Amihud (1994)	Monthly and quarterly stock market and exchange rate data for 32 US exporting firms covering the period 1979-1988.	Several regressions of the return of the portfolio of US exporting firms on the relative changes in the exchange rate index controlling for the return on the market portfolio are performed.	A statistically significant relationship between exchange rate changes and stock returns of US exporting firms has not been confirmed.
29	Domestic political risk, global economic policy uncertainty, and banks' profitability: evidence from Ukrainian banks	Athari (2020)	Data for 55 operating banks over the period 2005 to 2015. Variables include liquidity, bank size, capital adequacy ratio, asset quality, credit risk, operational efficiency, concentration, financial market structure, political risk index, inflation, global economic policy uncertainty	Pooled OLS regressions, fixed effects method and panel-corrected standards errors method used.	The profitability of Ukrainian banks depends positively on domestic political stability and negatively on global economic policy uncertainty.

Table 4.7: Profitability determinants - Literature review

	Title	Authors	Dataset	Determinants	Methodology	Conclusions
1	Determinants of Profitability: Evidence from Industrial Companies Listed on Muscat Securities Market	Al-Jafari and Al Samman (2015)	Oman industrial firms from 2006 to 2013	1. Tax rate 2. Size Growth 3. Fixed assets 4. Leverage 5. Working capital	Panel OLS	Profitability is enhanced in the case of large growing firms
2	Firm-specific and economy wide determinants of firm profitability: Greek evidence using panel data	Asimakopoulos et al. (2009)	Greek firms for the period 1995 to 2003	1. Size 2. Leverage 3. Sales Growth 4. Investment 5. Assets 6. EMU, Euro dummy variables	Pooled panel OLS regression, FE model, RE model	Size, investment and sales growth affect profitability positively. Leverage and assets affect negatively.
3	Determinants of Tunisian hotel profitability: The role of managerial efficiency	Ben Aissa and Goaied (2016)	Unbalanced panel data of 27 Tunisian hotel firms from 2000 to 2010	1. Size 2. Efficiency score 3. Age 4. Leverage 5. Management contact dummy 6. International chain dummy 7. Site dummy 8. Coast dummy 9. Attraction 10. Crisis dummies 11. Education & Tenure	The empirical specification is based on random effects estimation method	There is a significant impact of managerial efficiency , among the other determinants, on hotel profitability.
4	Profitability determinants of fitness SMEs: Empirical evidence from Portugal using panel data	De Carvalho et al. (2013)	182 Portuguese fitness firms for the period 2004-2009	1. Size 2. Age 3. Liquidity 4. Debt 5. Growth 6. Risk 7. Subsidies	Panel FE model, RE model	All the determinants affect profitability in a positive way excepting risk which affects negatively and growth which is a neutral determinant.
5	Determinants of Profitability: Evidence from Power and Energy Sector	Fareed et al. (2016)	Firms of power and energy sector in Pakistan from 2001 to 2012.	1. Lagged profitability 2. Size 3. Growth 4. Age 5. Leverage 6. Productivity 7. Electricity crisis	FE panel model	Productivity and size are the strongest determinants of profitability.
6	Determinants of growth and profitability in small entrepreneurial firms	Glancey (1998)	Data for 38 firms in Scotland for a three year period 1988-1990.	1. Size 2. Age 3. Location 4. Growth 5. Sector dummy	OLS and 2OLS models.	The larger of the small firms grow faster and the older firms grow slower compared to the younger.
7	Determinants of profitability in European manufacturing and services: Evidence from a dynamic panel model	Goddard et al. (2005)	Manufacturing and service sector firms in France, Italy , Belgium and UK, from 1993 to 2001.	1. Lagged ROA 2. Total assets 3. Market share 4. Non-current liabilities + loans (gearing) 5. Liquidity	Arellano and Bond (1991) GMM estimation of dynamic panel model	The relationships profitability-size and profitability-gearing are negative. The profitability-market share and profitability-liquidity relationships are positive.
8	Determinants of bank profitability in emerging markets	Kohlscheen et al. (2018)	Data for 534 banks from 19 emerging markets from 2000 to 2014	1. Lagged ROA 2. Loan growth rate 3. Size 4. Capital/assets ratio 5. Liquidity 6. Share of funding not obtained from consumer deposits 7. Operational expenses/gross revenues ratio 8. GDP, Spread of 5-year default swap, CPI, Inter-bank Rate, 10-year bond yield rate	Arellano and Bover (1995) GMM estimation of dynamic panel model.	Higher long-term interest rates increase profitability while higher shot-terms rates decrease it.

	Title	Authors	Dataset	Determinants	Methodology	Conclusions
9	The determinants of firm profitability in Australian manufacturing	McDonald (1999)	Annual data on Australian manufacturing firms over the 1983-1993 period.	1. Lagged Price-cost margin 2. Imports 3. Sales 4. Concentration 5. Sector 6. Market share 7. Wage inflation 8. Unemployment rate 9. Capital Stock	Arellano and Bond (1991) GMM estimation of dynamic panel model	Union density and imports affect profitability negatively. Profit margins are persistent over time and the effect of wages inflation is negative.
10	A panel data analysis of profitability determinants-Empirical results from Sri Lankan manufacturing companies	Pratheepan (2014)	Data for Sri Lankan manufacturing companies from 2003 to 2012	1. Size 2. Leverage 3. Liquidity 4. Tangibility	OLS, Random effects and Fixed effects methods of panel estimation are applied	Size significantly affects profitability in a positive way while the effect of tangibility is negative.
11	Profitability of small- and medium-sized enterprises in high-tech industries: The case of the biotechnology industry	Qian and Li (2003)	Annual data for 67 firms from 1995 to 1997	1. Innovator position 2. Market awareness 3. Product scope 4. Internationalization 5. Size 6. Age 7. Leverage 8. Firm risk 9. Past performance	Piecewise linear least-squares regression	Internationalization, innovator position, market awareness and niche operation, affect profitability positively.
12	Competing models of firm profitability	Slade (2004)	Annual panel data from 14 nonferrous-metal mining and refining markets for the period	1. Hirschman-Herfindahl index of concentration 2. Four-firm concentration ratio 3. Firm market share 4. Firms beta	A descriptive approach is followed based on a principal components analysis.	The empirical analysis finds a positive relationship between profitability and market structure.
13	Determinants of Profitability: An Analysis of Large Australian Firms	Stierwald (2010)	Data for 961 Australian firms from 1995 to 2005.	1. Lagged profit rate 2. Productivity 3. Employees 4. Leverage 5. Age 6. Financial Risk	Fixed effects, random effects and system GMM methods are used to estimate the dynamic profit model.	Productivity affects profitability positively. Sector effects are not of the same magnitude.
14	Profitability determinants among micro firms: Evidence from Swedish data	Yazdanfar (2013)	Data for 12530 Swedish firms from 2006 to 2007.	1. Lagged profitability 2. Productivity 3. Size 4. Age 5. Growth 6.	A seemingly unrelated regression (SUR) method is selected.	The effect of age factor on profitability is negative. Size, growth, productivity and lagged profitability affect positively.
15	Strategy and industry effects on profitability: Evidence from Greece	Spanos et al. (2004)	Data on Greek manufacturing firms for the years 1995-1996.	1. Industry variables (concentration, advertising, capital intensity, cost efficiency, tech intensity, growth) 2. Firm strategy variables 3. Unobservable effects (size, exports, share, flexibility, capital intensity)	OLS regressions	Firm-specific factors are stronger determinants of profitability compared to the industry factors. Generic and hybrid strategies are the more profitable.
16	The Determinants of Corporate Profitability in the UK Electrical Engineering Industry	Grinyer and McKiernan (1991)	Data for 45 firms in the UK Electrical Engineering Industry for the period 1972-1977	1. Asset to sales ratio 2. Sales to export ratio 3. Growth of sales 4. Competition 5. Entry/Exit barriers 6. Efficiency of admin 7. Market share 8. Sales 9. Relative growth	Multiple Single equation regression models.	Market share, growth of sales, capital intensity and decentralization have a positive effect on profitability.
17	The determinants of banks' profits in Greece during the period of EU financial integration	Kosmidou (2008)	Unbalanced panel of 23 banks for the 1990-2002 period	1. Cost to income 2. Equity to assets 3. Liquidity 4. Loan loss reserves ratio 5. Size	Fixed Effect method is adopted	Lower cost to income increases ROA. The effect of equity to assets is positive.

	Title	Authors	Dataset	Determinants	Methodology	Conclusions
18	Profitability Determinants of the Greek Hospitality Industry: The Crisis Effect	Dimitropoulos (2017)	Annual data for Greek firms in the accommodation an food sector over the 2011-2013 period.	1. Size 2. Capital intensity 3. Leverage 4. Liquidity 5. Cash flow 6. Sales 7. Tax rate	OLS regression method is followed.	Sales, size and cash flow have a positive effect. Increased levels of leverage and capital intensity decrease profitability.
19	Innovation, ownership and profitability	Love et al. (2009)	Panel data for manufacturing plants in Ireland from 1991 to 2002.	1. Employment 2. Vintage 3. Capital intensity 4. Staff with degree 5. Exports 6. Market share 7. Herfindahl Index 8. Industry & location dummies 9. Innovation	Quantile regression method is followed	The determinants of profitability vary over the profitability distribution. Determinants are different between innovators and non-innovators.
20	Macroeconomic and Industry-Specific Determinants of Greek Bank Profitability	Zampara et al. (2017)	Data from the Greek banking sector for the 2001-2014 period.	1. Growth rate of total assets 2. Growth rate of total deposits 3. Assets market share 4. Deposits market share 5. GDP 6. Unemployment rate	A multiple regression analysis is performed and OLS estimation is used.	Growth rate of deposits and assets market share have a positive impact. Growth rate of assets and deposits market share affect negatively.
21	Bank-specific, industry-specific and macroeconomic determinants of bank profitability	Athanasoglou et al. (2005)	Panel data of Greek banks from 1985 to 2001	1. Lagged ROA or ROE 2. Capital 3. Credit risk 4. Productivity 5. Expenses management 6. Size 7. Industry specific (ownership, concentration) 8. Macroeconomic (inflation, GDP deviations)	FE, RE estimations and one-step GMM estimation of Arellano & Bond	The bank specific variables, excepting size, are significantly affecting profitability. Labor productivity growth has a positive effect, credit risk and operating expenses have a negative impact .
22	Competencies, Innovation And Profitability Of Firms	Leiponen (2000)	Panel data for Finnish manufacturing firms from 1987 to 1993	1. Competence 2. Innovation 3. Sales 4. Market share 5. Capital intensity 6. Lagged profitability	A two-stage GMM estimation method by Arellano and Bond (1991) is followed	There is a positive effect of research and competence on profitability. Competencies play a more important role for the innovators.
23	The financial performance of large and small firms: evidence from Greece	Papadogonas (2007)	Data for 3035 Greek manufacturing firms for the 1995-1999 period.	1. Age 2. Size 3. Leverage 4. Sales growth 5. Investment 6. Sales 7. Exports dummy	OLS regression corrected for heteroscedasticity is used.	The effect of size, debt structure, investment rate and sales growth on profitability is significantly positive.
24	Determinants of Firm Performance: The Relative Importance of Economic and Organizational Factors	Hansen and Wernerfelt (1989)	A sample of 60 Fortune 1000 firms.	1. Economic (industry profitability, size) 2. Organizational	Regressions for economic, organizational and integrated model.	Both the economic and organizational components are significant determinants.
25	The Impact of R&D Investment on Productivity–New Evidence Using Linked R&D–LRD Data	Lichtenberg and Siegel (1991)	20493 manufacturing firms from 1972 to 1981	Alternative measures of R&D	The empirical approach is based on regressions of DTFP (total factor productivity growth) on various measures of R&D and also on regressions of rate of return on R&D expenditure.	The returns to R&D investment have a positive sign. R&D investment is a significant determinant of DTFP.
26	Determinants of firm profitability in the Croatian manufacturing industry: evidence from dynamic panel analysis	Pervan et al. (2019)	Data on 9359 Croatian manufacturing firms for the period 2006-2015	1. Lagged ROA 2. Age 3. Liquidity (Assets/Liabilities) 4. Labour cost 5. Hirschman-Herfindahl index 6. Capital intensity 7. Inflation rate 8. GDP growth	Arellano and Bond (1991) GMM estimation of dynamic panel model	Age is a positive determinant of profitability. Labour and market concentration effects are negative while the macroeconomic impact is positive.

	Title	Authors	Dataset	Determinants	Methodology	Conclusions
27	The impact of R&D on productivity increase in Japanese manufacturing companies	Odagiri and Iwata (1986)	Data for 311 Japanese manufacturing firms for two periods: 1966-1973 and 1974-1982	1. R&D expenditure 2. Size 3. Advertising 4. Sales increase 5. Net worth/assets increase	Linear regressions are estimated	Rate of return depends on the presence of industrial dummies and inter-industry differences.
28	Determinants of Firm Performance: Evidence from Romanian Listed Companies	Lazăr (2016)	Data for Romanian stock market firms for the 2000-2011 period.	1. Size 2. Leverage 3. Tangible Assets 4. Labour 5. Sales growth 6. Value added	A two-way fixed effects model with time dummies is used	The effect of sales growth and value added is positive. The sign for the rest of the regressors is negative.
29	Determinants of return-on-equity in USA, German and Japanese manufacturing firms	Weidman et al. (2019)	A sample of USA, German and Japanese manufacturing and electronic firms with data from 2016 financial statements	1. Net profit margin 2. Total assets 3. Equity multiplier	A cross-sectional log-linear multivariate regression analysis is performed	The effect of net profit margin on ROE is the most important of the determinants.
30	Employees, firm size and profitability in U.S. manufacturing industries	Becker-Blease et al. (2010)	Data from 109 US manufacturing industries from 1987 to 2002	1. Employment 2. Sales 3. Concentration 4. Risk 5. Market to book ratio	Several EBITDA/TA regressions are estimated	Profitability is negatively affected by the number of employees. The relationship between profitability and size is industry-specific
31	Determinants of Banks' Profitability: Evidence from EU 27 Banking Systems	Petria et al. (2015)	Annual data for 1098 EU27 banks for the period 2004 to 2011.	1. Size 2. Capital adequacy 3. Credit Risk 4. Cost/Income ratio 5. Liquidity risk 6. Business Mix index 7. Concentration 8. Inflation 9. Economic growth	A panel FE model is used to estimate the effect on ROAA or ROAE.	The findings show a significant effect of determinants on ROAA or ROAE.
32	Rethinking and redefining the determinants of corporate profitability	Batra and Kalia (2016)	Data from financial reports for 50 companies for 2013 financial year.	1. Fixed assets ratio 2. Current ratio 3. Debt-equity ratio	Two alternative models (One with return on capital as dependent variable and the other with return on net worth) are estimated via OLS regression methods	The relationship between firm size and profitability is significantly positive. The effect of capital structure is negative and there is an insignificant effect of liquidity.
33	The determinants of bank profitability: empirical evidence from European banking sector	Menicucci and Paolucci (2016)	Panel data of 35 European banks for the period 2009-2013.	1. Size 2. Capital ratio 3. Loan ratio 4. Deposits 5. Loan loss	The empirical approach is based on descriptive and regression analysis methods.	The impact of determinants on bank profitability is statistically significant and positive with the exception of loan loss provisions which gave a negative sign.
34	Leverage, Risk, Market Structure and Profitability	Hurdle (1974)	Panel dataset of 231 US manufacturing firms for the period 1960-1969.	1. Absolute deviation in annual profits 2. Leverage 3. Market share 4. Growth of sales 5. Concentration 6. Advertising 7. Capital/sales ratio 8. Assets 9. Demand variance	The empirical model is estimated using OLS and 2-stage least squares methods.	The market structure is the strongest determinant for the explanation of profit differences.
35	Profitability in Portuguese service industries: a panel data approach Paulo	Maçãs Nunes et al. (2009)	Panel data for 75 Portuguese service firms from 1999 to 2003	1. Lagged Profitability 2. Size 3. Growth 4. Leverage 5. Liquidity 6. Tangibility	Several estimation methods are used including random effects, fixed effects, OLS, Arellano and Bond (1991) GMM, system GMM)	There is a positive lagged effect of profitability. The effect of size and growth of sales is positive while the impact of debt and tangibility is negative.
36	The Persistence of Profits: A European Comparison	Geroski and Jacquemin (1988)	The sample includes 134 UK, France and West Germany firms for the period 1949-1982	1. Exports 2. Growth of sales 3. Age 4. Ownership dummy 5. Degree of specialization 6. Concentration	An autoregressive model is used to describe long-run profitability, persistence of profits and the role of factors that	In UK profits persist in many cases and the profits are more predictable compared to France and West Germany. Variation in

	Title	Authors	Dataset	Determinants	Methodology	Conclusions
				7. Industry and national dummy	induce variations in long-run profits. A regression analysis is used to search for the factors associated with systematic variations across firms	profits is lower in the case of UK.
37	Financial Ratio Analysis as a Determinant of Profitability in Nigerian Pharmaceutical Industry	Innocent et al. (2013)	Data from 5 Nigerian pharmaceutical companies for the period 2001-2011	1. Inventory 2. Debt 3. Credit velocity 4. Total assets	OLS estimation method of the empirical model is applied	The relationship between profitability and determinants is negative.
38	Determinants of Profitability: An Empirical Investigation Using Australian Tax Entities	Feeny (2000)	A sample of 180738 Australian tax entities from 1994 to 1997.	1. Size 2. Gearing 3. Capital intensity 4. Market share 5. Concentration 6. Trademark intensity 7. Minimum Efficient scale	Multivariate regression are run at 3 digit industry level and presented for each coefficient in graphs.	There is a positive effect of size of entity and concentration. Market share and profitability relationship follows an U-shape.
39	The Determinants of Profitability : Evidence from Malaysian Construction Companies	Zaid et al. (2014)	Data for construction companies in Malaysia from 2000 to 2012	1. Capital structure 2. Liquidity 3. Size 4. Economic cycle 5. GDP 6. Interest rate	GLS method is used to estimate the parameters of the profitability empirical model	Liquidity and firms size is significantly related to profitability.
40	Profit Margin And Capital Structure: An Empirical Relationship	Eriotis et al. (2011)	Panel data for 53 firms for the years 1995-1996	1. Concentration ratio 2. Debt to equity 3. Investment	A pooled model, a FE model and a RE model are used	The impact of debt/equity ratio on profitability is negative and strong.
41	Determinants of Profitability in the Greek Tourism Sector Revisited: The Impact of the Economic Crisis	Agiomirgianakis et al. (2013)	Data for 134 hotels from 2006 to 2010	1. Age 2. Firm Size 3. Leverage 4. Inventory 5. Crisis proxy	A panel EGLS method is used for the estimation of the empirical model.	Sales (size proxy), age and inventories over total assets ratio affect profitability negatively. The effect of the crisis proxy (interest rate spreads) and of the leverage is negative.
42	The determinants of corporate financial performance in the Bermuda insurance market	Adams and Buckle (2003)	Data from 47 Bermuda insurance companies for the period 1993-1997.	1. Size 2. Risk 3. Leverage 4. Liquidity 5. Type of company 6. Scope	The empirical model is examined carrying out a multivariate pooled panel regression analysis.	The leverage and risk factor effect is significantly positive and the effect of liquidity is negative. The size and scope are not statistically significant determinants of firm performance.

Chapter 5

Conclusions

This thesis is intended to shed more light on the effects of economic uncertainty on business decisions. Specifically, it is intended to contribute to the empirical literature of uncertainty effects on investment and profitability with a primary focus on the Greek firm. This contribution is three-fold. First, it employs a very large panel dataset of annual data on 25,000 Greek firms' balance sheets. Second, it covers the period before and after the financial crisis. Third, it takes into account the multidimensional and heterogeneous nature of the business environment and reveals the uncertainty effects across sectors, quantiles and different firm sizes.

The Greek case proved to be the appropriate one for our investigation. The wide time windows of the analysis (2000 to 2014) covered periods of low uncertainty and high growth, periods of steep and prolonged recession, international financial turbulences and noticeable peaks and troughs in economic uncertainty. The construction of the uncertainty indicator for Greece was the first challenge to face in our empirical research. The aim was to find a proxy that could clearly match the key economic and political events of the country without disregarding the contribution of the European and international factor. Thus, we decomposed the uncertainty effects at three groups: a domestic, EU and international. The dynamic factor model we employed synthesized the large dataset into a composite index that reflects the main uncertainty events of the sample period.

The first approach was to augment the standard investment model with the constructed index. The adopted framework which is based on Tobin's *q* theory of investment was estimated following the Arellano-Bond method. We followed a multilevel analysis by employing the empirical model on aggregate, firm size, sector and within sector level. The results revealed a high degree of heterogeneity. The impact of uncertainty on economic activity and on the firm investment found to be negative and substantially increased in the years of crisis. The Manufacturing, Real Estate and Hotels sectors were the more affected. The uncertainty effect depended on the firm size and was more weak for the larger firms. Alternative interaction terms and uncertainty indices confirmed the robustness of the results.

The second essay described a similar framework but focused on the differentiation between investment levels. To answer the question if the large firms are different for the small ones in terms of investment we adopted a panel quantile estimation technique. The uniqueness of this approach in the empirical literature provided us with really interesting findings. There was a negative effect of volatility on firm's investment decisions. In contrast with the simplified approach of the conditional mean we revealed a different response across quantiles. For firms with higher investments rates that belong to the upper quantiles the impact was stronger. At different levels of analyses small firms of the upper quantiles and the sectors of Transportation, Construction, Real Estate, and Mining faced larger investment losses.

In the last chapter of our thesis the GMM dynamic model and the panel quantile regression model of the two first essays are employed in order to examine the profitability-uncertainty relationship. As in the case of investment under uncertainty the profitability rate decreased when economic volatility raised. Heterogeneity appeared when we classified our sample based on the annual turnover percentile ranking and when we applied the model at the sectoral level. Larger firms were less vulnerable to uncertainty effects. Volatility fluctuations were observed for the firsts and for the last quantiles of the profitability distribution.

Undoubtedly, the most important finding of our thesis is that we succeed to uncover the heterogeneous character of the uncertainty influence. We expected that this influence would be negative. However, we didn't expect to observe quite different results among sectors. We were also quite impressed to find that the magnitude of the economic volatility effect depends not only on the size of the firm but also on the quantile it belongs, a result with important implications for policymakers and regulatory authorities. We examined investment and profitability as two key elements of the business decision-making process. We started with investment under uncertainty in order to apply on the Greek case the theoretical and empirical models of the already rich literature. Then, we chose profitability as a new field of empirical research to extend the scope of our thesis. The results proved to be robust and important. Someone could argue that it is quite expected as in an uncertain environment any business decision and result could be affected. However, it is not always feasible to get qualitatively attractive results something that we succeed at both of our approaches, investment and profitability. Further research on other aspects of business activity could be promising and it might unveil similar effects of economic uncertainty.

Last but not least this thesis introduced a new uncertainty index for Greece to be the major determinant of our econometric analysis. We incorporated several macroeconomic variables and financial indicators and we managed to capture the most important macroeconomic events of the last decade. Last years a number of economic policy uncertainty indices appeared for Greece following the newspaper-based methods. Since these works were not available at the beginning of our research they could be an important update for our uncertainty index. Furthermore, the ongoing COVID-19 pandemic brings to light the role of the health crisis, an unfamiliar path to most researchers. The link between health crisis, uncertainty and economic crisis raises puzzles for future research.