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What is the Investment Loss due to Uncertainty?

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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

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"Although our intellect always longs for clarity and certainty,
our nature often finds uncertainty fascinating"
Carl von Clausewitz

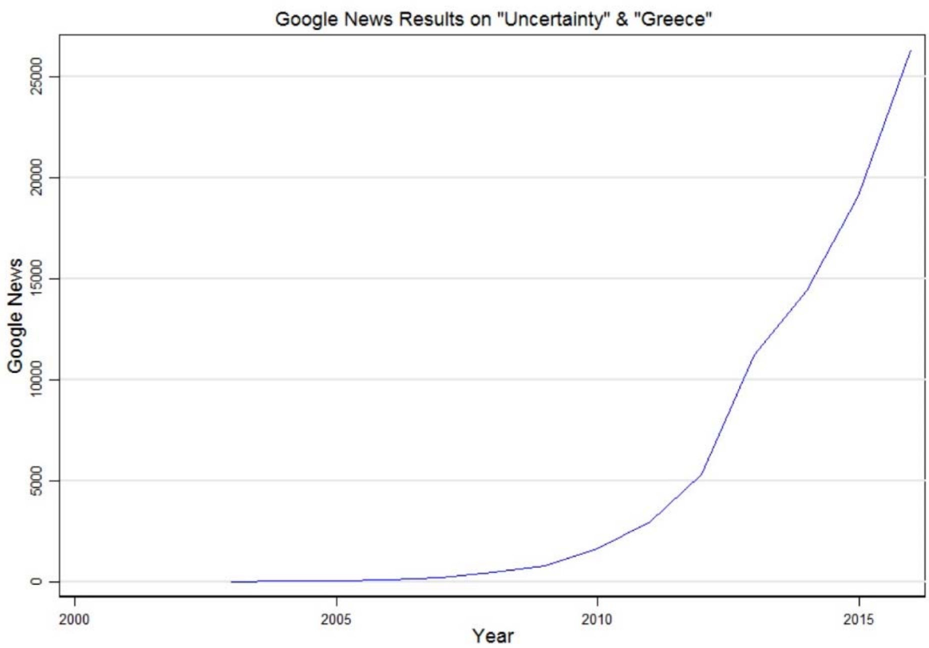
1 Introduction

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 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 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 0 reviews the theoretical and empirical literature on uncertainty and investment. Section 0 outlines the econometric specification of the study and Section 0 discusses the data and the measures of uncertainty. Results are presented in Section 0. The last one concludes and provides policy implications.

2 Literature review

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 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

[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)

[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).

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

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.

[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)

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

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 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 A1 in the online 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.

2.3 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 in 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 A2 in the online Appendix summarizes the existing studies that focus on Greece.

3 Empirical Specification

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:

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

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):

$$\varepsilon_{it} = c_i + \zeta_t + e_{it} \quad (2)$$

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 investment8. 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 ratio9, small and private firms are excluded from the sample. Bond et 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

[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.

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] .

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:

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

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

[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)

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.

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.

[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).

3.3 Estimation technique

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

$$y_{it} = \alpha w_{it} + \beta x_{it} + c_i + u_{it} \quad (4)$$

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:

$$E(c_i) = E(u_{it}) = E(c_i u_{it}) = E(u_{it} u_{is}) = 0$$

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

$E(x_{it} u_{is}) = 0 \; for \; all \; s \geq t$ (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" 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].

[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.

[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.

4 Data and Uncertainty proxy

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:

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

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

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

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

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

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

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.

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

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 1.

Table 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 provide evidence against the null hypothesis. As a result, we can treat the first differences as stationary processes.

Table 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 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 4. The unobserved factor will serve as a proxy for the uncertainty and is illustrated in Figure 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 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			

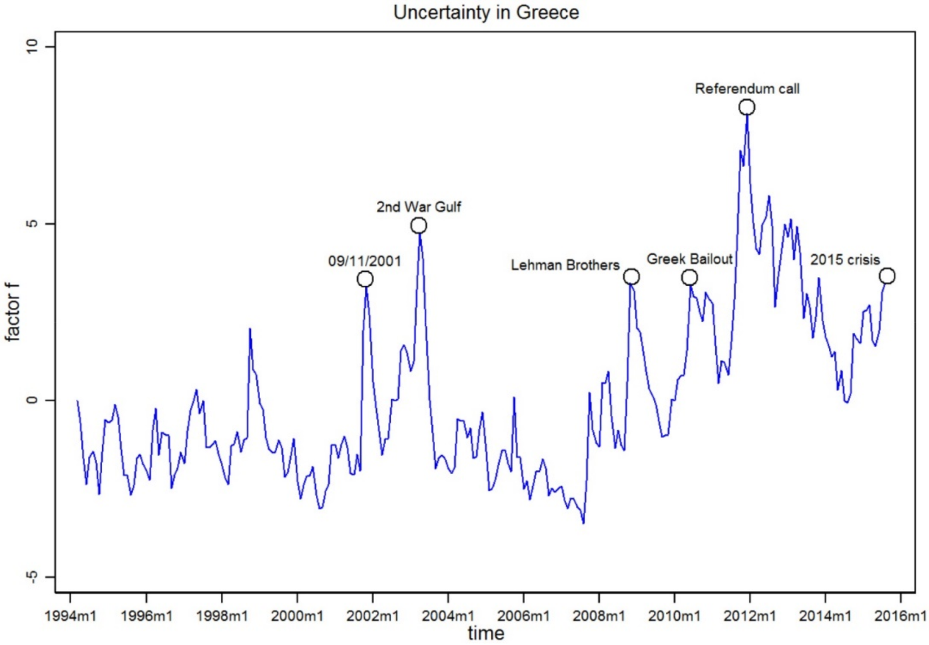
Notes: Sample size N=9, T=258. Tests are based on a maximum number of factors $r=3$. All estimation were performed using Matlab (R2016a). The codes are available at the author's web pages.

Table 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: Uncertainty Proxy



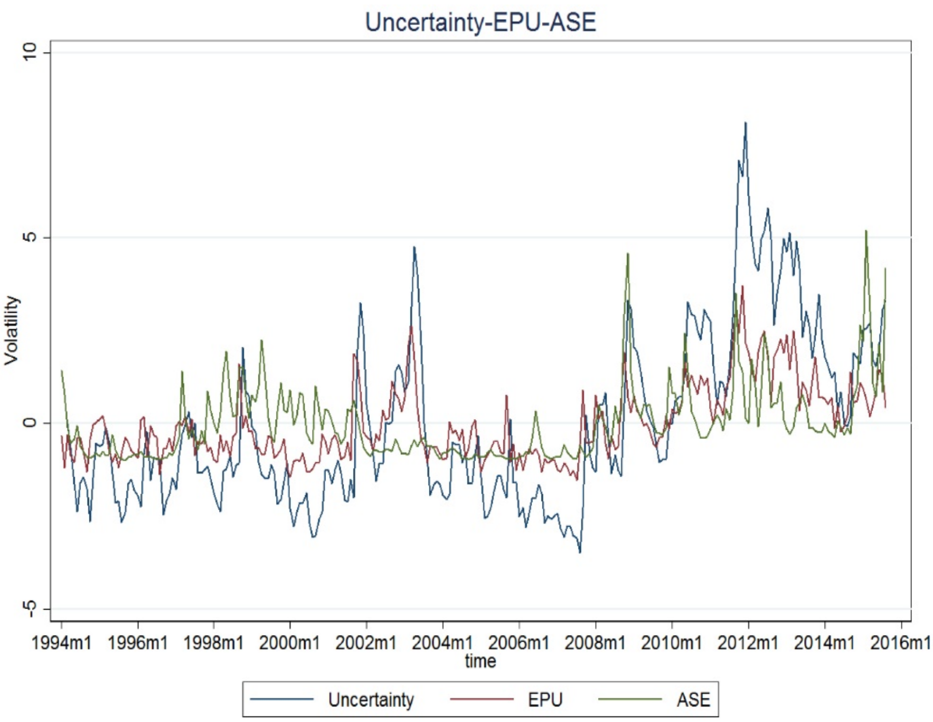
The derived uncertainty index can capture the most important macroeconomic events of the last decade and seems to follow closely the main political and economic episodes of the Greek financial crisis. Focusing on the coefficients of the unobservable factor one can argue that the strongest contribution 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 5). These variables are highly correlated with the computed uncertainty proxy. The patterns of EPU, ASE and the constructed index are compared in Figure 3. In the robustness section, we will also confirm our results with alternative measures of uncertainty.

Table 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 3: Economic Uncertainty-EPU-ASE



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 unbalancedness. 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 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 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/

[18] 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 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.

As a first step in the analysis of the sectors of the Greek economy, we provide their descriptive statistics in Table A3 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.

Table 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

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?

5.1 Aggregate level

We start with the results for the aggregate level that are reported in Table 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 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 financially 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 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 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

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 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.

[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)

Table 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 5^{th} and 95^{th} 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

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 11 and in Table A4 in the online 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 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.

Table 11: GMM Estimates of Investment Rate – Sector Level – Summary Table

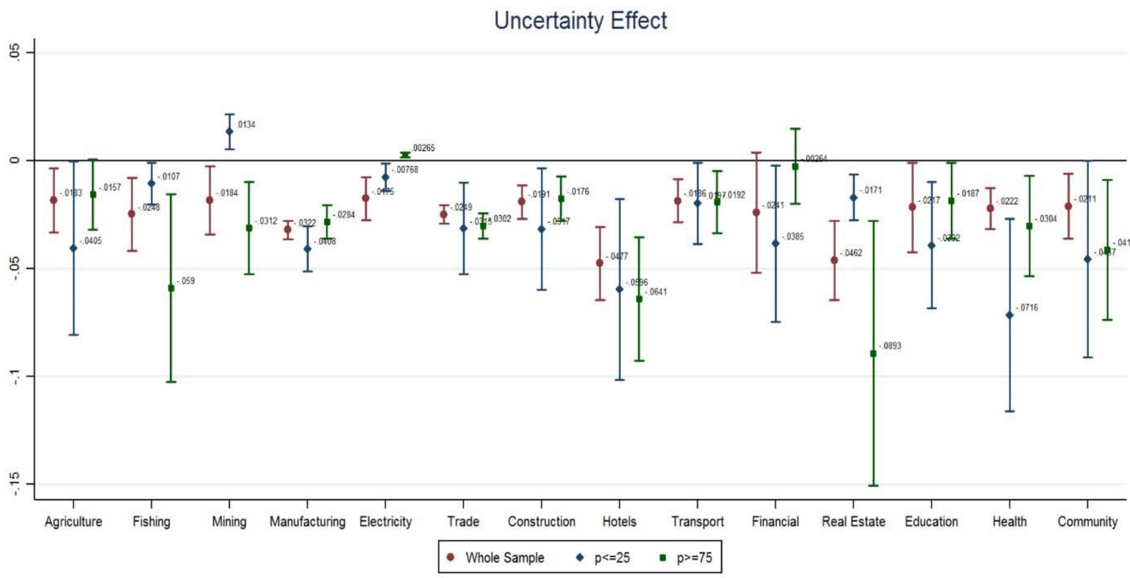
Time	Variable	Agriculture	Fishing	Mining	Manufacturing	Electricity	Trade	Construction
Sector level	I/K	0.146^{*}	0.168^{**}	0.243^{**}	0.151^{***}	0.135^{**}	0.075^{***}	0.133^{***}
	CF/K	-0.030	0.402^{***}	0.293^{*}	0.184^{***}	-0.263	0.067^{***}	0.207^{**}
	GS/K	0.137^{**}	-0.047^{**}	-0.100^{**}	-0.028	-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. 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 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 A7 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.

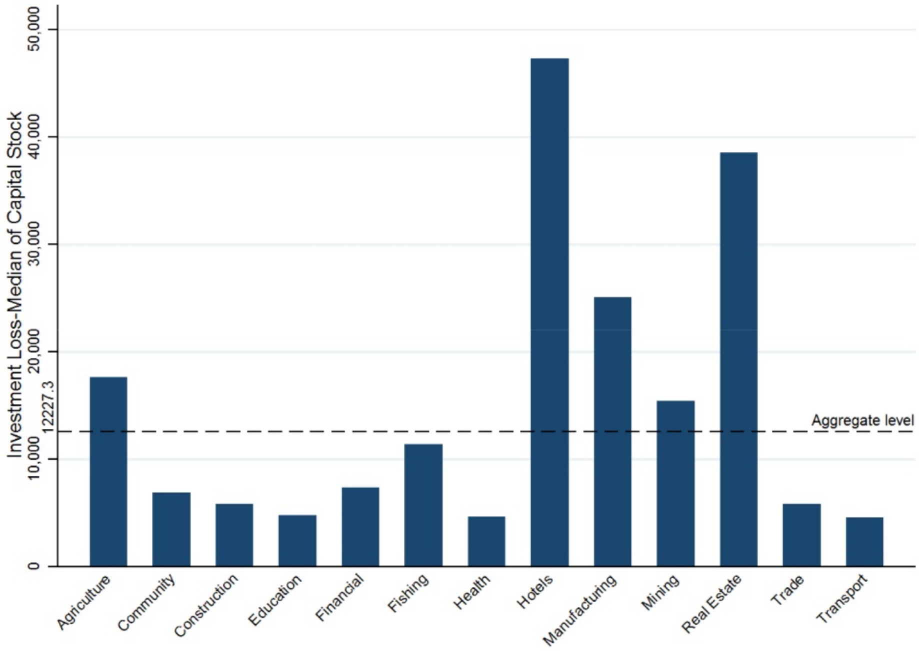
We attempt to quantitatively assess the impact of uncertainty by calculating the investment loss for each of the economic sectors. The investment loss is the marginal effect of uncertainty on investment rate, ceteris paribus, multiplied by the median value of the capital stock. We excluded the electricity sector because of its extreme capital stock values. The results are presented in Figure 5. 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 4: Uncertainty Effect on Investment – Sector level



Note: 95% confidence intervals are plotted; For illustrative purposes mining sector uncertainty was rescaled to 10% and large financial firms' confidence interval to 5%

Figure 5: Investment Loss



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 11 and Tables A5 & A6 in the Appendix. For illustrative purposes, Figure 4 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.

6 Robustness Analysis

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 12 and in Figure 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 the 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 13 and a comparison graph of the uncertainty effect is presented in Figure 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.

Another deviation from the model one would consider is a model with time dummies. Figure 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 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 16 also provides the starting fixed effects estimates of the aggregate model of section 5.1 which is in line with our previous results.

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

Table 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

Figure 6: Robustness Analysis – The Role of Debt

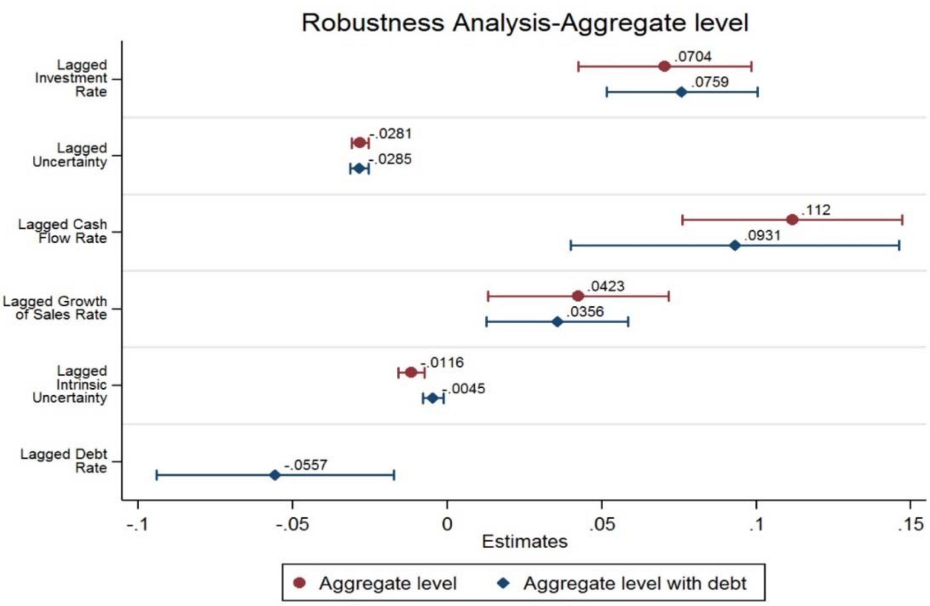


Table 13: Robustness Analysis – The Role of Debt – Sector Level

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 7: Robustness Analysis – Sector level

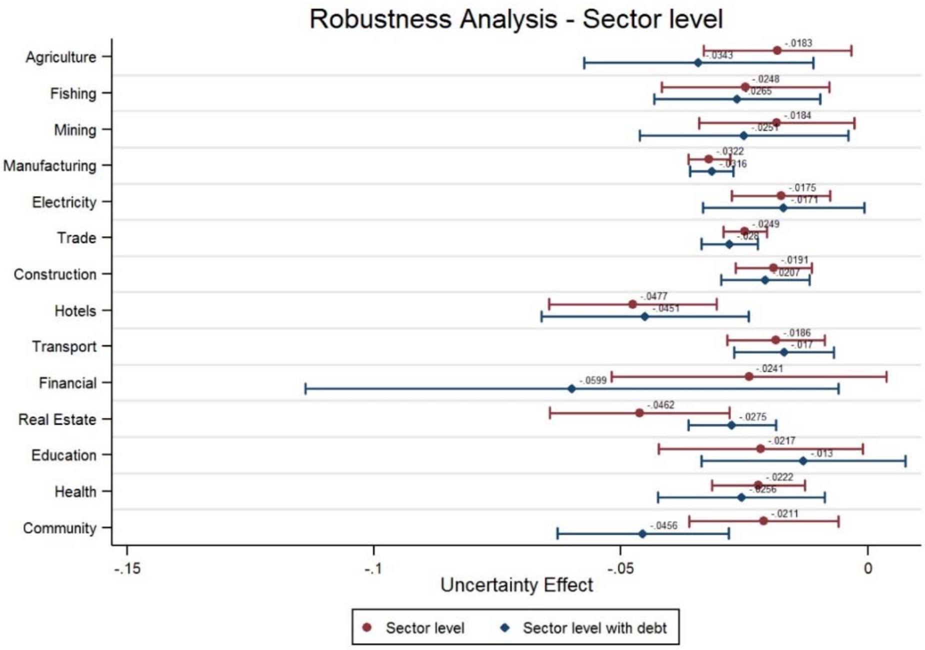


Table 14: Robustness Analysis –Interaction Terms

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

Table 15: 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

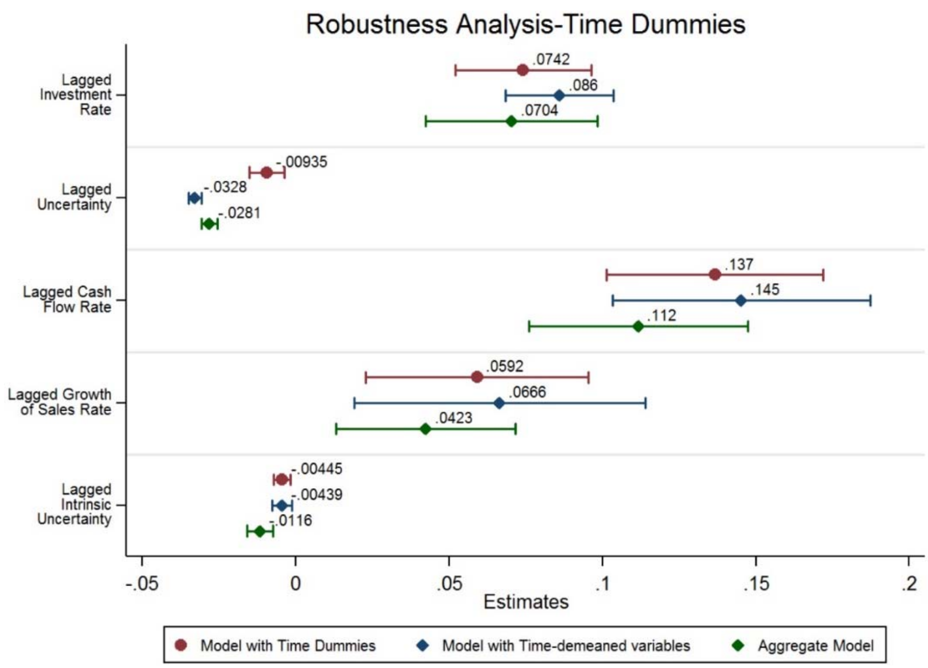
Notes: The models are estimated using the first-difference Arellano-Bond estimator developed by Arellano and Bond (1991) and implemented in STATA 14 by Roodman (2009). Robust standard errors are reported in braces. Sargan-Hansen J-test is a test of overidentifying restrictions. AR (2) is the Arellano 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

Table 16: 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)
ht-1	–0.019***	(0.000)	–0.022***	(0.000)
idt-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 8: Robustness Analysis – The Role of Time Dummies



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 14. 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 provides similar coefficient values and more support to the robustness of our model.

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 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 15. 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.

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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A Online Appendix

Table A1: 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.
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 macro-economic 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.

Table A1 (continued)

	Title	Authors	Data	Methodology	Conclusions
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 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.
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.

Table A1 (continued)

	Title	Authors	Data	Methodology	Conclusions
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.
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.

Table A1 (continued)

	Title	Authors	Data	Methodology	Conclusions
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 confi-dence index, unemploy-ment, Moody's bonds, S&P500 index, IEM pre-sidential 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.
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. (2013)	Two datasets for the period 1959–2001, one of 132 US macroeconomic time series and one of 147 financial series.	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 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.	Much variability in the popular uncertainty proxies is not driven by uncertainty but belongs to forecastable fluctuations 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.

Table A1 (continued)

	Title	Authors	Data	Methodology	Conclusions
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 other two models include only each one of the two types of uncertainty.	Both types of uncertainty appear to have a negative impact on private firms' investment. The investment behaviour is more sensitive to the idiosyncratic 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 A2: 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 employed to assess the impact of uncertainty on activity.	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 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 A3: 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 A4: 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 (p-value)	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) p-value	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 A5: 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 (p-value)	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) p-value	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 A6: 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 (p-value)	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) p-value	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 A7: 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 (p-value)	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) p-value	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

Table A7 (continued)

Variable	Non-Metallic Mineral	Basic Metals	Fabricated Metals	Machinery & Equipment	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 (p-value)	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) p-value	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