ISSN 1791-3144

**University of Macedonia
Department of Economics**

Discussion Paper Series

**Investment and Uncertainty:
Are large firms different from small ones?**

Theodore Panagiotidis and Panagiotis Printzis

Discussion Paper No. 6/2021

Department of Economics, University of Macedonia, 156 Egnatia str, 546 36 Thessaloniki, Greece,
Fax: + 30 (0) 2310 891292
<http://www.uom.gr/index.php?newlang=eng&tmima=3&categorymenu=2>

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

Theodore Panagiotidis
University of Macedonia,
Thessaloniki, Greece
tpanag@uom.edu.gr

Panagiotis Printzis
University of Macedonia,
Thessaloniki, Greece
pprintzis@gmail.com

Abstract

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

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

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

1 Introduction

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

This paper quantifies the investment loss due to uncertainty.¹ We consider an economy that has faced increased uncertainty. Greece provides a useful case study for this investigation since it experienced a prolonged economic recession and turbulent periods of increased uncertainty. We employ a dataset that includes 25000 Greek firms' balance sheets covering all sectors and different firm sizes. A panel quantile estimation framework is employed to obtain a comprehensive picture of the heterogeneous effect of uncertainty. We address this heterogeneity across quantiles for each of the sectors. The results reveal a negative effect of uncertainty on investment. Furthermore, quantile regressions provide evidence of a within-sector heterogeneity based on the firm's investment rates. Firms that invest more face amplified uncertainty effects. They are more vulnerable to the impact of uncertainty. On the other side, firms with lower investment rates are affected less. A classification based on the firms' annual turnover gives a better overall picture of the heterogeneity across quantiles. Smaller firms that invest more are the most affected. Digging a bit deeper, at the sectoral level, we find that the magnitude of the negative uncertainty effect varies across and within sectors.

Our paper relates to the growing empirical literature of investment under uncertainty. To our knowledge, it is the first that examines the different effects of uncertainty on relatively large and relatively small firms. We apply quantile estimation techniques to gauge the

¹ We focus on economy-wide uncertainty proxied by the common unobserved factor of a dynamic factor model applied on a set of 9 economic indicators from 1994M01 to 2015M08.

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

The paper is organized as follows: Section 2 reviews the literature. Section 3 outlines the econometric specification and Section 4 presents the data and the measures of uncertainty. The results are presented in Section 5. The last one concludes and provides policy implications.

2 Literature review

One of the first discussions on the modern concept of uncertainty belongs to Knight (1921). The Knightian uncertainty was an initial approach to distinguish between uncertainty and risk and it described the situation where the knowledge about the probability distribution is limited or incomplete. Keynes (1937) expressed also the same suggestion in his famous quote: *"We simply don't know"*. Their work nurtured a rich theoretical literature about the effects of uncertainty. The precautionary motive theory, the Oi-Hartman-Abel effects theory, and the growth options mechanism suggest a positive sign for the uncertainty effect. The risk aversion behavior and the real options of irreversible investment lead to a negative impact of uncertainty.² The majority of the theoretical approaches focus on the real options theory and are reviewed in the seminal work of Dixit and Pindyck (1994).

On the empirical side, most studies indicate a negative relationship between uncertainty and investment. Uncertainty can undermine investment and could affect business decisions. The empirical literature, until the early 2000s, is reviewed in Carruth et al. (2000), Lensink et al. (2001), and Butzen and Fuss (2003). For a more recent reviews see Forbes (2016) and

² For Keynes, the precautionary motive is one of the three mechanisms that drive liquidity preferences (the others are the transaction and speculative motives). The Oi-Hartman-Abel theory, based on the models of Abel (1983); Hartman (1972); Oi (1961), states that in the case of convex profits more uncertainty will lead to increased expected profits since prices with greater variability get more probability weight. The growth options mechanism describes the situation of increased expected profits and stimulated investment activity because of an increase in uncertainty. The risk aversion theory supports the connection between increasing uncertainty and increased risk premium which leads to an increased cost of finance with negative effects on investment decisions. The real options theory (Bernanke (1983); Black and Scholes (1973); Cox and Ross (1976); Merton (1973)) is based on the assumption that investment projects take place in conditions of irreversibility and any new information over time provides the investor the option to delay the project.

Panagiotidis and Printzis (2019)³. Influential works include Bond et al. (2005), Bloom et al. (2007, 2019), Baum et al. (2008), Bloom (2009), Baker et al. (2013), and Henzel and Rengel (2013). Table 5 in the Appendix summarizes the latest studies.

A popular approach in empirical modelling followed by many studies is based on Tobin's q theory of investment, where the q -ratio of the market value of assets to its book value relates investment to the firm's market valuation. This is considered as an index of the firm's investment behavior (Tobin, 1969). The empirical strategy usually employs a dynamic investment model estimated using procedures that rely on GMM techniques such as Arellano and Bond (1991) and Blundell and Bond (1998). We will follow a similar approach but within a different estimation framework based on panel quantile regression method. This allows us to model the entire conditional distribution of the response variable and estimate the effect of uncertainty for different levels of investment (high and low). The latter avoids simplistic approaches that are based on sub-sample regressions. The literature on quantile regression methods for panel data is still growing. A recent contribution to the investment literature that adopts panel quantile estimation techniques includes Akron et al. (2020) and Koc and Sahin (2017).

3 Empirical Specification

3.1 Estimation technique – Panel Quantile Regression

We employ a panel quantile regression framework for two reasons. First, quantile regression models are more robust to outliers and perform better in conditions of non-normality. Second, such models take into account the impact of the covariates on the entire conditional distribution of the response variable and provide a more accurate description of the relationship. As a result, we can obtain a more comprehensive picture of the heterogeneity of the effect of uncertainty on investment. Quantile estimation for the cross-section case was originally introduced by Koenker and Bassett (1978) and extended to the case of longitudinal data in Koenker (2004). The model specification for the conditional quantile functions⁴ is given by:

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

³ Panagiotidis and Printzis (2019) also present the existing literature that focuses on Greece which is limited.

⁴ According to Koenker and Hallock (2001) conditional quantile functions are the “....models in which quantiles of the conditional distribution of the response variable are expressed as functions of observed covariates.”

where $Q_{y_{it}}(\tau|x_{it})$ is the τ th conditional quantile function of the response of the t th observation on the i th individual y_{it} , c_i is a fixed effect acting as a pure location shift independent of τ and $x'_{it}\beta(\tau)$ the covariates that depend upon the quantile τ . If a lag of the response variable y_{it-1} is present as a regressor the model takes the dynamic form:

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

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

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

where $\rho_{\tau}(u) = u(\tau - I(u < 0))$ is the quantile loss function of Koenker and Bassett (1978) and u_k are the weights controlling the relative influence of the Q quantiles $\{\tau_1, \dots, \tau_Q\}$ on the estimations of the parameters c_i . Galvao (2011) argues that (3) suffers from bias because of the presence of the lagged dependent variable y_{it-1} and proposes the use of instrumental variables to produce a consistent estimator. His method follows Chernozhukov and Hansen (2005, 2006, 2008) using lagged regressors as an instrument. Canay (2011) adopted a simpler approach for the static model through data transformation that eliminates the fixed effects c_i as $T \rightarrow \infty$. This is a two-step estimation method. Fixed effects regression is applied to estimate the unobserved fixed effects. In the second step, the fitted variable is used in a quantile regression to estimate $\beta(\tau)$. However, in the case of short panels with small T the estimation of fixed effects is no longer consistent (this case is closer to the dataset we will employ later on).⁵ Rosen (2009), Ponomareva (2011), and Kato et al. (2012) take into account this problem and provide alternative specifications. Machado and Santos Silva (2019) propose a restricted version of the standard formulation of $Y_{it} = X'_{it}\beta(U'_{it})$, $U'_{it} \sim \text{Uniform}(0,1)$ based on conditional means which allows for nonlinear quantile effects and allows the individual effects to affect the entire distribution. Powell (2014) introduces an estimator with non-additive fixed effects. The main advantage of this approach is that it is consistent for small T and that it bypasses the specification of the fixed effects. The estimation uses GMM allowing the instruments to be arbitrarily correlated with the non-

⁵ The approach of Sarafidis and Weber (2015) and Christodoulou and Sarafidis (2017) could also be considered in this case.

additive fixed effects. It also provides consistent estimates for the dynamic case where a lagged dependent variable is present. Following the notation of Powell (2014), the model is:

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

where D are the treatment variables, $U_{it}^* \sim U(0,1)$ and $U_{it}^* = f(c_i, U_{it})$. The function $f(\cdot)$ is unknown and the individual fixed effects c_i are not estimated. U_{it} acts as a rank variable and is a representation of proneness for the outcome thus, U_{it}^* is a function of a fixed and a random proneness. It is worth mentioning that (4) is comparable to pooled instrumental variables quantile regression but not to additive fixed effects model. The latter estimate the distribution of $(Y_{it} - c_i)|D_{it}$ instead of $Y_{it}|D_{it}$. Thus, pooled quantile regression provides a similar interpretation of the parameters and can be used as a robustness test ⁶.

3.2 Empirical model

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

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

where I is the investment, K the capital stock, CF the cash flow, GS the growth of sales, $id_{i,t}$ the idiosyncratic uncertainty, h_t the economic uncertainty. $\left(\frac{I}{K}\right)_{it}(\tau)$ expresses the conditional distribution for any given $\tau \in (0,1)$. High (low) values indicate firms with relative strong (weak) investment performance. To account for the past investment behavior and the lagged investment effect, we include the lagged investment rate $\left(\frac{I}{K}\right)_{it-1}$ in the model. CF and GS variables reflect the firms' investment opportunities and the growth potential.⁷ Following studies in this strand of the literature, we use a model of investment

⁶ Recent theoretical work includes also Galvao and Kato (2016); Geraci and Bottai (2007); Graham et al. (2016); Lamarche (2010).

⁷ Baum et al (2010) were among the first to examine the interaction between cash flow and uncertainty. Section 6 considers their interaction.

that includes the growth of sales ratio.⁸ The main reason is that we use a full-range sample, in terms of firm size, with limited availability of stock market data. The alternative approach that could provide computable q measures was to select a sample of large stock-market firms. This would reduce the sample and the coverage of the Greek firms' investment behavior would be restricted. The uncertainty measure enter the model with their first lags to control for lags in decision making (manager's analyse information acquired from the previous period). A two-step GMM method is used to estimate parameters. Instruments are obtained from inside the model following the idea that regressors are correlated with their lagged values but not with the innovations.⁹ Thus, we can use lagged regressors as instruments. The estimation is based on the Markov Chain Monte Carlo (MCMC) optimization method.¹⁰

4 Data and Uncertainty proxy

4.1 Measuring Uncertainty

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

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

$$f_t = Cw_t + D_1f_{t-1} + D_2f_{t-2} + \dots + D_{t-p}f_{t-p} + \varepsilon_t \quad (7)$$

$$u_t = E_1u_{t-1} + E_2u_{t-2} + \dots + E_{t-q}u_{t-q} + v_t \quad (8)$$

where y_t is the vector of k dependent variables, f_t the unobserved factors, and x_t the exogenous variables. The simplified model¹¹ without the exogenous parts x_t and w_t is:

⁸ 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).

⁹ See Anderson and Hsiao (1981), (1982); Arellano and Bond (1991).

¹⁰ The model is estimated using a two-step GMM method developed by Powell (2014) and implemented in STATA (*qregpd* package). The optimization method employs adaptive MCMC sampling by the use of a multivariate normal proposal distribution. The MCMC algorithm works through acceptance-rejection sampling in order to reach a target acceptance rate. For a more detailed description of the adaptive MCMC method see Baker (2014) and Andrieu and Thoms (2008).

¹¹ The model is estimated by maximum likelihood (ML) in a state-space form and using the Kalman filter. Several information criteria are applied to determine the number of dynamic factors: Bai and Ng (2002), Bai and Ng (2007), Hallin and Liska (2007), Onatski (2009), Barigozzi et al. (2016), Guo-Fitoussi (2013), Hallin and Liska (2007) and Onatski (2009). Results suggest the use of one factor and they are presented in Panagiotidis and Printzis (2019).

$$y_t = Af_t + u_t \quad (9)$$

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

Panagiotidis and Printzis (2019) use a set of 9 economic indicators from 1994M01 to 2015M08 to estimate the model. The variables, their sources and the transformations are presented in Table 1. An illustration of the unobserved factor is presented in Figure 1 annotated with the most important events of recent years. There is a clear match with the main economic events of the country.

Figure 1: Uncertainty proxy

Table 1: Macroeconomic variables and indices

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

Notes: X_t is the transformed variable and L is the lag-operator

*Data available on <http://www.policyuncertainty.com/>

The Economic Sentiment Indicator (ESI) and the Business Climate Indicator (BCI) are survey based indices conducted by the Directorate General for Economic and Financial Affairs (DG ECFIN). In Greece, the surveys are conducted by the Foundation of Economic & Industrial Research (FEIR/IOBE). See also (Panagiotidis and Printzis (2019)).

4.2 Firm-level Panel Data

We use an unbalanced panel of the 25000 larger Greek firms (turnover > 100000€) from 2000 to 2014. The annual balance sheets were obtained from the Infobank Hellastat database (IBHS)¹² and cover the main economic sectors of the Greek economy (see Table 2).

¹² See <http://www.cbfa.gr/>. The sample follows the national statistical classification of economic activities, (STAKOD-03) which is derived from the corresponding classifications of European Union (NACE Rev. 1.1) and United Nations (ISIC 3.1)

Table 2: Sectors of economic activity in Greece

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

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

We construct the following variables: Investment (I) is the capital expenditures in material fixed assets, equal to the change of the net value of fixed assets plus the year depreciation, capital stock (K) is the book value of total fixed assets, cash flow (CF) are the net profits plus depreciation, growth of sales (GS) is the change in sales S (annual turnover), idiosyncratic Uncertainty (id_{it}) is proxied by the standard deviation of scaled sales estimated in a 5-year rolling window and uncertainty (h_t) is the common unobserved factor as estimated by the dynamic factor model. Data are trimmed at the 5th and 95th percentile to eliminate potential outliers. Firms with missing observations were not included in the sample. Descriptive statistics are presented in Tables 3 and 4.

Table 3: Descriptive Statistics

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

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

Table 4: Sectors' Descriptive Statistics

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

Variable	Hotels		Transport		Construction		Real Estate	
	mean	sd	mean	sd	mean	sd	mean	sd
I/K	0.126	0.172	0.179	0.293	0.161	0.262	0.145	0.247
CF/K	0.098	0.119	0.868	1.859	0.584	1.137	0.556	1.477
GS/K	-0.006	0.127	0.051	6.046	-0.171	4.293	-0.147	2.516
id_{it}	0.274	0.520	19.00 0	42.70 4	9.848	22.47 5	5.877	14.927
h_t	0.343	2.128	0.343	2.128	0.343	2.128	0.343	2.128

5 Results

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

5.1 Aggregate level

The results for the entire sample are reported in Table 5 and Figure 2. The Arellano-Bond estimation results are also reported (dash line). The impact of uncertainty on the investment

ratio is negative and statistically significant. However, it varies substantially across quantiles of the outcome distribution. This provides evidence of a considerable heterogeneity effect. Firms with higher investment ratio are more sensitive to uncertainty changes compared with the less aggressive firms, in terms of investment.¹³ Firms with relatively higher investment rate are more exposed to volatility fluctuations. The contribution of the idiosyncratic ($id_{i,t-1}$) term changes sign above the 25th quantile, from negative to positive. This implies that the investment performance of the relatively stronger investors is stimulated by an increasing variability of sales which seems to be a rather contradictory result. However, for the more aggressive firms, this could activate a growth option mechanism. The sign of the GS ratio is positive and in line with the theoretical findings. The impact of the cash flow coefficient is positive, statistically significant and implies the existence of financial constraints. Fazzari et al. (1988) and many subsequent empirical papers support the view that positive and high cash flow sensitivities belong to financially constrained firms that prefer internal financing or find it hard or costly to access external capital. In our case, this stands particularly for the firms that belong to the upper quantiles of the conditional distribution. The persistence characteristic of investment known as lagged investment effect is confirmed by the findings. It is positive and indicates that past behavior affects the firm's future decisions. The effect gets stronger across quantiles. Firms that invest aggressively exhibit more persistent investment behavior. On the other hand, the persistence effect is weaker for the firms that belong to the lower quantiles.

¹³ This could be coming from various channels but future research on this would be of interest.

Figure 2: Full Sample

Table 5: Quantile Regression – Full sample

Variable	q1	q5	q10	q15	q20	q25	q30	q35	q40	q45
$(I/K)_{i,t-1}$	0.0509*** (0.0007)	0.0872*** (0.0034)	0.0574*** (0.0001)	0.0249*** (0.0000)	0.0317*** (0.0000)	0.0460*** (0.0000)	0.0645*** (0.0000)	0.0809*** (0.0000)	0.1035*** (0.0000)	0.1258*** (0.0000)
$(CF/K)_{i,t-1}$	-0.0119*** (0.0001)	0.0071*** (0.0005)	0.0147*** (0.0000)	0.0064*** (0.0000)	0.0099*** (0.0000)	0.0152*** (0.0001)	0.0209*** (0.0000)	0.0281*** (0.0000)	0.0342*** (0.0000)	0.0393*** (0.0000)
$(GS/K)_{i,t-1}$	0.0032*** (0.0001)	0.0043*** (0.0001)	0.0058*** (0.0000)	0.0010*** (0.0000)	0.0019*** (0.0000)	0.0022*** (0.0000)	0.0026*** (0.0000)	0.0026*** (0.0000)	0.0031*** (0.0000)	0.0032*** (0.0000)
h_{t-1}	-0.0076*** (0.0001)	-0.0058*** (0.0001)	-0.0043*** (0.0000)	-0.0030*** (0.0000)	-0.0024*** (0.0000)	-0.0029*** (0.0000)	-0.0038*** (0.0000)	-0.0045*** (0.0000)	-0.0059*** (0.0000)	-0.0074*** (0.0000)
$id_{i,t-1}$	-0.0007*** (0.0000)	-0.0014*** (0.0000)	-0.0014*** (0.0000)	-0.0001*** (0.0000)	-0.0000*** (0.0000)	0.0000*** (0.0000)	0.0001*** (0.0000)	0.0001*** (0.0000)	0.0002*** (0.0000)	0.0002*** (0.0000)
Variable	q50	q55	q60	q65	q70	q75	q80	q85	q90	q95
$(I/K)_{i,t-1}$	0.1539*** (0.0000)	0.1696*** (0.0000)	0.2009*** (0.0000)	0.2106*** (0.0000)	0.2443*** (0.0001)	0.2391*** (0.0000)	0.2533*** (0.0000)	0.2458*** (0.0000)	0.2422*** (0.0000)	0.1858*** (0.0006)
$(CF/K)_{i,t-1}$	0.0448*** (0.0000)	0.0527*** (0.0000)	0.0607*** (0.0000)	0.0679*** (0.0000)	0.0738*** (0.0000)	0.0826*** (0.0000)	0.0935*** (0.0000)	0.1022*** (0.0001)	0.1028*** (0.0000)	0.0986*** (0.0001)
$(GS/K)_{i,t-1}$	0.0037*** (0.0000)	0.0034*** (0.0000)	0.0043*** (0.0000)	0.0038*** (0.0000)	0.0028*** (0.0000)	0.0036*** (0.0000)	0.0030*** (0.0000)	0.0041*** (0.0000)	0.0050*** (0.0000)	0.0015*** (0.0000)
h_{t-1}	-0.0091*** (0.0000)	-0.0113*** (0.0000)	-0.0137*** (0.0000)	-0.0152*** (0.0000)	-0.0183*** (0.0000)	-0.0214*** (0.0000)	-0.0238*** (0.0000)	-0.0275*** (0.0000)	-0.0282*** (0.0000)	-0.0290*** (0.0006)
$id_{i,t-1}$	0.0003*** (0.0000)	0.0003*** (0.0000)	0.0005*** (0.0000)	0.0008*** (0.0000)	0.0009*** (0.0000)	0.0013*** (0.0000)	0.0015*** (0.0000)	0.0024*** (0.0000)	0.0030*** (0.0000)	0.0030*** (0.0000)
Observations	91255	91255	91255	91255	91255	91255	91255	91255	91255	91255
Firms	18266	18266	18266	18266	18266	18266	18266	18266	18266	18266

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

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

At the second level of analysis, we classified the total sample in three categories of small, medium and large sized firms based on the annual turnover percentile ranking. The results are presented in Table 7 in the Appendix. Figure 3 summarizes the uncertainty effects for the three categories. The negative impact of uncertainty is more profound for the smaller firms that invest more, thus they seem to be more exposed. In contrast, small firms with lower investment rates are less affected and for certain quantile, the negative impact of uncertainty is near zero. For the large firms, the uncertainty effect also changes across quantiles. Relative larger firms with higher investment are affected less. On the other hand, large firms with lower investment rates, that is to say, they belong to the lower quantiles, are affected more.

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

Figure 3: The effect of uncertainty on small, medium and large firms

5.2 Sector level

The empirical model of equation 5 is applied to each of the sectors of economic activity in the case of Greece. The results of the quantile regressions are presented in Tables 8a-8c (Appendix). We focus on the effect of uncertainty. We summarize the regressions results in the combined graph presented at Figure 4. The uncertainty coefficient sign is negative for all sectors but the magnitude varies across and within sectors. For the first quantiles of the samples, the effects seem similar. More substantial differences appear above the median. In this case, the negative impact is found to be stronger on the Transportation sector, the Construction sector and the Mining sector. The effect is much smaller for the Agriculture and Hotels & Restaurants sectors. For the upper quantiles zone, firms in the Real Estate sector face also great investment losses. All in all, at the sector level there is a heterogeneous

investment effect under uncertainty. For several sectors, the negative effect takes values below the average while for several others the impact is much stronger. Across quantiles the heterogeneity increases. The coefficient values vary from close to zero to 0.323 for the 85th quantile of the Real Estate sector.

Figure 4: The effect of uncertainty for Sectors

To dig a bit deeper, we perform a disaggregate analysis of the manufacturing sector focusing on the two-digit SIC subsectors. Tables 9a-9g present the results and Figure 5 plots the uncertainty effect per quantile and subsector. Heterogeneity among subsectors is directly observable, especially in the upper quantiles zone. The effect of uncertainty is increasing along the quantiles and each subsector responds differently across quantiles.

Figure 5: The effect of uncertainty for Manufacturing two-digit Subsectors (NACE Rev. 1.1 & ISIC 3.1)

To provide a more tangible interpretation of the sectoral results, we gauge the impact of uncertainty by calculating the investment loss. The investment loss is defined as the marginal effect of uncertainty on investment rate, *ceteris paribus*, multiplied by the value of the capital stock. The results for all the sectors are presented in Figure 6. Below the median, the investment loss is rather small. The behavior changes above $q75$ and turns to be explosive. For the Real Estate and the Mining sectors an increase of uncertainty by one unit makes the investment loss to reach or exceed the level of one million euro. The main finding is that in terms of absolute losses the effect follows an exponential path across quantiles. Firms that invest more and own more capital stock i.e. more fixed assets are affected more in absolute terms.

Figure 6: Investment Loss for different sectors

6 Robustness Analysis

To check the robustness of our model, we consider an additional approach with the inclusion of the lagged leverage effect as a regressor. The new term is the lagged ratio $\left(\frac{D}{K}\right)_{it-1}$ where D is the total bank liabilities. The literature on the role of debt ratio provides mixed results depending on the firm's growth opportunities¹⁴ or on the uncertainty regime (Baum et al., 2010). The augmented model is presented in Table 10 and in Figure 7. The model performs similarly to the original approach. There is no significant change in the behavior of the coefficients across quantiles and this provides more support to the robustness of our findings. The leverage term switches its sign above the 25th quantile. Thus, less aggressive firms face negative effects of leverage on investment and are constrained by increased debt. On the other hand, for firms that invest more than the median the effect is strongly positive. The findings suggest that investment in Greece is financially constrained and any rise in the leverage ratio can boost the investment performance.

¹⁴ See Ahn et al. (2006) for a brief literature review on leverage and investment.

Figure 7: Robustness Analysis – with Leverage Effect

We extend the original model by incorporating interaction terms between uncertainty, GS ratio and CF ratio. The aim is to examine the robustness of the model and to investigate the uncertainty effects on investment through alternative channels. The results are presented in Table 11 and Figure 8 and confirm the original specification. The transmission mechanism of the volatility effect through the alternative channels is mostly negative and the evolution of the coefficients across quantiles varies. There is a switch of the sign only in the lower quantiles of the GS interaction effect and in the higher quantiles of the CF interaction effect. The results indicate that the impact of GS ratio and CF ratio on investment is weakening under uncertainty. In other words, the investment response on GS and CF decreases in conditions of increased economic volatility. This result could be a sign of a “wait and see” effect, an indication of a precautionary behavior that makes firms to defer or to cancel projects and to prefer to wait. The literature of investment under uncertainty in a partial irreversibility framework suggests similar results.

Figure 1 displays eight time series plots comparing Quantile Regression (solid blue line) and Arellano-Bond (dashed grey line) estimates for various variables from 1995 to 2008. The x-axis for all plots represents time, with labels Q5, Q25, Q50, Q75, and Q95. The y-axis for each plot represents the variable's value.

- Lagged Investment Effect:** The y-axis ranges from 0 to 2.5. The Quantile Regression line shows a steady increase from approximately 0.5 in 1995 to 2.0 in 2008, while the Arellano-Bond line remains relatively flat around 0.5.
- Uncertainty Effect:** The y-axis ranges from -0.03 to 0. The Quantile Regression line starts near -0.01, peaks around -0.005 in 1997, and then declines to approximately -0.025 by 2008. The Arellano-Bond line is flat at 0.
- Growth of Sales Effect:** The y-axis ranges from 0 to 0.008. The Quantile Regression line shows a peak around 0.004 in 1997, a dip, and then a rise to a second peak around 0.006 in 2007, before declining. The Arellano-Bond line is flat at 0.
- Cash Flow Effect:** The y-axis ranges from 0 to 0.15. The Quantile Regression line shows a steady increase from approximately 0.01 in 1995 to 0.12 in 2008. The Arellano-Bond line is flat at 0.
- Idio-Uncertainty Effect:** The y-axis ranges from -0.001 to 0.002. The Quantile Regression line shows a sharp dip to -0.001 in 1996, then rises to approximately 0.0015 by 2008. The Arellano-Bond line is flat at 0.
- Leverage Effect:** The y-axis ranges from -0.01 to 0.02. The Quantile Regression line shows a steady increase from approximately -0.005 in 1995 to 0.015 in 2008. The Arellano-Bond line is flat at 0.
- Interaction Effect:** The y-axis ranges from -0.003 to 0.002. The Quantile Regression line shows a peak around 0.001 in 1996, then declines to approximately -0.002 by 2008. The Arellano-Bond line is flat at 0.
- h*cf:** The y-axis ranges from -0.003 to 0.002. The Quantile Regression line shows a peak around 0.001 in 1996, then declines to approximately -0.002 by 2008. The Arellano-Bond line is flat at 0.

Legend: — Quantile Regression, - - - - - Arellano-Bond

¹⁵ The key phrases are: Greek-Greece crisis, Greek debt crisis, Greece bailout, Greek debt, Grexit, Greece uncertainty.

21

Figure 9: Robustness Analysis – Alternative measures of Uncertainty

We complete the battery of robustness checks with a pooled quantile regression estimation at aggregate and sector level and a further approach based on the Machado and Santos Silva (2019) model. The results are summarized in Table 12 and Figures 10,11 & 12. The broad inferences of our main empirical model remain intact. The pooled quantile regression estimates are qualitatively similar. The restricted model of Machado and Santos Silva (2019) relies on very strong and restrictive assumptions regarding exogeneity and n/T ratio. The n/T ratio of our panel dataset is large and may lead to bias in the asymptotic distribution. The assumptions of strict exogeneity and no serial correlation do not hold for the lagged dependent variable as well as for the rest of the regressors. The statistical significance of the lagged investment effect and the growth of sales is low. However, for uncertainty and cash flow effects the key results are maintained, they are of the same magnitude and have the same sign.

Figure 10: Robustness Analysis – Pooled Quantile Regression

Figure 11: Robustness Analysis – The effect of Uncertainty at the Sectoral Level- Pooled Quantile Regression

Figure 12: Robustness Analysis – Machado and Santos Silva (2019) quantile regression

7 Conclusions

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

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

References

- Abel, A.B. (1983), "Optimal Investment under Uncertainty", *The American Economic Review*, Vol. 73 No. 1, pp. 228–233.
- Abrevaya, J. and Dahl, C.M. (2008), "The Effects of Birth Inputs on Birthweight", *Journal of Business & Economic Statistics*, Taylor & Francis, Vol. 26 No. 4, pp. 379–397.
- Ahn, S., Denis, D.J. and Denis, D.K. (2006), "Leverage and Investment in Diversified Firms", *Journal of Financial Economics*, Vol. 79 No. 2, pp. 317–337.
- Akron, S., Demir, E., Díez-Esteban, J.M. and García-Gómez, C.D. (2020), "Economic policy uncertainty and corporate investment: Evidence from the U.S. hospitality industry", *Tourism Management*, Vol. 77.
- Anderson, T.W. and Hsiao, C. (1981), "Estimation of Dynamic Models with Error Components", *Journal of the American Statistical Association*, Taylor & Francis, Ltd.American Statistical Association, Vol. 76 No. 375, p. 598.
- Anderson, T.W. and Hsiao, C. (1982), "Formulation and estimation of dynamic models using panel data", *Journal of Econometrics*, North-Holland, Vol. 18 No. 1, pp. 47–82.
- Andrieu, C. and Thoms, J. (2008), "A tutorial on adaptive MCMC", *Statistics and Computing*, Vol. 18 No. 4, pp. 343–373.
- Arellano, M. and Bond, S. (1991), "Some Tests of Specification for Panel Data: Monte Carlo Evidence and an Application to Employment Equations", *The Review of Economic Studies*, Vol. 58 No. 2, pp. 277–297.
- Asker, J., Farre-Mensa, J. and Ljungqvist, A. (2011), "Comparing the Investment Behavior of Public and Private Firms", *National Bureau of Economic Research Working Paper Series*, No. 17394.
- Badertscher, B., Shroff, N. and White, H. (2013), "Externalities of Public Firm Presence : Evidence from Private Firms' Investment Decisions", *Journal of Financial Economics*, Vol. 109 No. 3, pp. 682–706.
- Bai, J. and Ng, S. (2002), "Determining the Number of Factors in Approximate Factor Models", *Econometrica*, Vol. 70 No. 1, pp. 191–221.
- Bai, J. and Ng, S. (2007), "Determining the Number of Primitive Shocks in Factor Models", *Journal of Business & Economic Statistics*, Vol. 25 No. 1, pp. 52–60.
- Baker, M.J. (2014), "Adaptive Markov chain Monte Carlo sampling and estimation in Mata", *Stata Journal*, Vol. 14 No. 3, pp. 623–661.
- Baker, S.R., Bloom, N. and Davis, S.J. (2013), "Measuring Economic Policy Uncertainty", *Chicago Booth Research Paper*, No. 13–02.
- Baker, S.R., Bloom, N. and Davis, S.J. (2015), "Measuring Economic Policy Uncertainty", *Quarterly Journal of Economics*, Vol. 131 No. 4, pp. 1593–1636.
- Barigozzi, M., Lippi, M. and Luciani, M. (2016), "Non-Stationary Dynamic Factor Models for Large Datasets", *Finance and Economics Discussion Series 2016-024*.
- Baum, C.F., Caglayan, M. and Talavera, O. (2008), "Uncertainty Determinants of Firm Investment", *Economics Letters*, Vol. 98 No. 3, pp. 282–287.
- Baum, C.F., Caglayan, M. and Talavera, O. (2010), "On the Investment Sensitivity of Debt under Uncertainty", *Economics Letters*, Vol. 106 No. 1, pp. 25–27.
- Baum, C.F., Caglayan, M. and Talavera, O. (2010). On the Sensitivity of Firms' Investment to Cash Flow and Uncertainty. *Oxford Economic Papers*, 62, 286–306.
- Bernanke, B.S. (1983), "Irreversibility, Uncertainty, and Cyclical Investment", *The Quarterly Journal of Economics*, Vol. 98 No. 1, pp. 85–106.
- Black, F. and Scholes, M. (1973), "The Pricing of Options and Corporate Liabilities", *The Journal of Political Economy*, Vol. 81 No. 3, pp. 637–654.
- Bloom, N. (2009), "The Impact of Uncertainty Shocks", *Econometrica*, Vol. 77 No. 3, pp. 623–685.
- Bloom, N., Bond, S. and Van Reenen, J. (2007), "Uncertainty and Investment Dynamics", *Review of Economic Studies*, Vol. 74 No. 2, pp. 391–415.
- Bo, H. (1999), "The Q Theory of Investment: Does Uncertainty Matter ?", *University of Groningen, SOM Research Institute*, s.n.
- Bond, S.R., Moessner, R., Mumtaz, H. and Syed, M. (2005), "Microeconomic Evidence on Uncertainty and Investment", *Institute for Fiscal Studies*.
- Butzen, P. and Fuss, C. (2003), "Firms' Investment and Finance Decisions", Research Department, National Bank of Belgium.
- Canay, I. (2011), "A simple approach to quantile regression for panel data", Vol. 14, pp. 368–386.
- Carruth, A., Dickerson, A. and Henley, A. (2000), "What Do We Know About Investment Under Uncertainty?", *Journal of Economic Surveys*, School of Economics, University of Kent, Vol. 14, pp. 119–136.
- Chernozhukov, V. and Hansen, C. (2005), "An IV Model of Quantile Treatment Effects", *Econometrica*, Vol. 73 No. 1, pp. 379–398.
- Chernozhukov, V. and Hansen, C. (2006), "Instrumental quantile regression inference for structural and treatment effect models", *Journal of Econometrics*, Vol. 132 No. 2, pp. 491–525.
- Chernozhukov, V. and Hansen, C. (2008), "Instrumental variable quantile regression : A robust inference approach", *Journal of Econometrics*, Vol. 142 No. 2008, pp. 379–398.
- Christodoulou, D. and Sarafidis, V. (2017), "Regression clustering for panel-data models with fixed effects", *Stata Journal*, Vol. 17 No. 2, pp. 314–329.
- Cox, J.C. and Ross, A.S. (1976), "The Valuation of Options for Alternative Stochastic Processes", *Journal of Financial Economics*, Vol. 3, pp. 145–166.
- Dixit, A. and Pindyck, S. (1994), *Investment Under Uncertainty*, Princeton University Press.
- Fazzari, M.S., Hubbard, R.G. and Petersen, B.C. (1988), "Financing Constraints and Corporate Investment", *Brookings*

- Papers on Economic Activity*, Vol. 1988 No. 1, pp. 141–195.
- Forbes, K. (2016), “Uncertainty about Uncertainty”, *J.P. Morgan Cazenove “Best of British” Conference, London*.
- Galvao, A.F. (2011), “Quantile regression for dynamic panel data with fixed effects”, *Journal of Econometrics*, Elsevier B.V., Vol. 164 No. 1, pp. 142–157.
- Galvao, A.F. and Kato, K. (2016), “Smoothed quantile regression for panel data”, *Journal of Econometrics*, North-Holland, Vol. 193 No. 1, pp. 92–112.
- Geraci, M. and Bottai, M. (2007), “Quantile regression for longitudinal data using the asymmetric Laplace distribution”, *Biostatistics*, Vol. 8 No. 1, pp. 140–154.
- Ghosal, V. and Lounyani, P. (2000), “The Differential Impact of Uncertainty on Investment in Small and Large Businesses”, *Review of Economics and Statistics*, Vol. 82 No. 2, pp. 338–343.
- Graham, B.S., Hahn, J., Poirier, A. and Powell, J.L. (2016), “A Quantile Correlated Random Coefficients Panel Data Model”, No. March 2008.
- Guo-Fitoussi, L. (2013), “A Comparison of the Finite Sample Properties of Selection Rules of Factor Numbers in Large Datasets”, *Munich Personal RePEc Archive*, No. 50005.
- Hallin, M. and Liska, R. (2007), “Determining the Number of Factors in the General Dynamic Factor Model”, *Journal of the American Statistical Association*, Vol. 102 No. 478, pp. 603–617.
- Hartman, R. (1972), “The Effects of Price and Cost Uncertainty on Investment”, *Journal of Economic Theory*, Vol. 5 No. 2, pp. 258–266.
- Henzel, S.R. and Rengel, M. (2013), “Dimensions of macroeconomic uncertainty : A common factor analysis”, No. 167.
- Jurado, K., Ludvigson, S.C. and Ng, S. (2015), “Measuring Uncertainty”, *American Economic Review*, Vol. 105 No. 3, pp. 1177–1216.
- Kato, K., Galvao, A.F. and Montes-Rojas, G. V. (2012), *Asymptotics for panel quantile regression models with individual effects*, *Journal of Econometrics*, North-Holland, Vol. 170, available at: https://econpapers.repec.org/article/eeeeconom/v_3a170_3ay_3a2012_3ai_3a1_3ap_3a76-91.htm (accessed 3 December 2017).
- Keynes, J.M. (1937), “The General Theory of Employment”, *The Quarterly Journal of Economics*, Vol. 51 No. 2, pp. 209–223.
- Knight, F. (1921), *Risk, uncertainty and profit*, Library of Economics and Liberty.
- Koc, U. and Sahin, H. (2017), “Cash-Flow and Investment: a Panel Quantile Approach”, *Empirical Economics Letters*, Vol. 16 No. 2, pp. 131–141.
- Koenker, R. (2004), “Quantile regression for longitudinal data”, *Journal of Multivariate Analysis*, Vol. 91 No. 1, pp. 74–89.
- Koenker, R. and Bassett, G. (1978), “Regression Quantiles”, *Econometrica*, Vol. 46 No. 1, pp. 33–50.
- Koenker, R. and Hallock, K.F. (2001), “Quantile Regression”, *Journal of Economic Perspectives*, Vol. 15 No. 4, pp. 143–156.
- Lamarche, C. (2010), “Robust penalized quantile regression estimation for panel data”, *Journal of Econometrics*, North-Holland, Vol. 157 No. 2, pp. 396–408.
- Lensink, R., Bo, H. and Sterken, E. (2001), *Investment, Capital Market Imperfections and Uncertainty: Theory and Empirical Results*, Edward Elgar Publishing.
- Machado, J.A.F. and Santos Silva, J.M.C. (2019), “Quantiles via moments”, *Journal of Econometrics*, Elsevier B.V., No. xxxx, doi:10.1016/j.jeconom.2019.04.009.
- Merton, R.C. (1973), “Theory of Rational Option Pricing”, *The Bell Journal of Economics and Management Science*, Vol. 4 No. 1, pp. 141–183.
- Oi, W.Y. (1961), “The Desirability of Price Instability Under Perfect Competition”, *Econometrica*, Vol. 29 No. 1, pp. 58–64.
- Onatski, A. (2009), “Testing Hypothesis about the Number of Factors in Large Factor Models”, *Econometrica*, Vol. 77 No. 5, pp. 1447–1479.
- Panagiotidis, T. and Printzis, P. (2019), “What is the Investment Loss due to Uncertainty?”, *Global Finance Journal*.
- Ponomareva, M. (2011), “Quantile Regression for Panel Data Models with Fixed Effects and Small T : Identification and Estimation”, *Working Paper; University of Western Ontario*, pp. 1–19.
- Powell, D. (2014), “Quantile Regression with Nonadditive Fixed Effects”, available at: http://works.bepress.com/david_powell/1.
- Rashid, A. (2011), “How does Private Firms’ Investment Respond to Uncertainty?: Some Evidence from the United Kingdom”, *The Journal of Risk Finance*, Vol. 12 No. 4, pp. 339–347.
- Rashid, A. and Saeed, M. (2017), “Firms’ Investment Decisions – Explaining the Role of Uncertainty”, *Journal of Economic Studies*, Vol. 44 No. 5, pp. 833–860.
- Rosen, A. (2009), *Set identification via quantile restrictions in short panels*, *The Institute for Fiscal Studies Department of Economics, UCL*, available at: <http://www.cemmap.ac.uk/wps/cwp2609.pdf> (accessed 2 December 2017).
- Sarafidis, V. and Weber, N. (2015), “A Partially Heterogeneous Framework for Analyzing Panel Data”, *Oxford Bulletin of Economics and Statistics*, Vol. 77 No. 2, pp. 274–296.
- Whited, T.M. and Wu, G. (2006), “Financial Constraints Risk”, *Review of Financial Studies*, Vol. 19 No. 2, pp. 531–559.