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WHY DEMAND UNCERTAINTY CURBS INVESTMENT: EVIDENCE FROM A PANEL OF ITALIAN MANUFACTURING FIRMS

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Abstract

Theoretically, the effect on investment of uncertainty over the demand for a firm's product may be unclear because of the influence of several factors, such as the production technology and the amount of competition in the product market. It has not been possible, until now, to investigate more closely the interplay of different factors in the time dimension because the empirical research has been based on cross-section analysis. This omission makes biased estimates of the investment-uncertainty relationship likely. The aim of this paper is to extend the findings of the empirical literature using a panel of Italian firms in the period 1996-2004, covering a complete business cycle. The availability of panel survey data on companies' investment plans, expected future sales and demand uncertainty allows us to account for unobservable individual differences between firms, macroeconomic shocks and the evolution of the investment-uncertainty relationship. A key finding of our paper concerns the role of the competition encountered by Italian firms in 1996-2004. The gradual loss of market power over time of Italian manufacturing firms, along with the increasing flexibility of labour input may have weakened the negative effect of uncertainty on investment decisions. We show that, in repeated cross-section estimates, the omission of firm-specific effects together with the dynamic interplay described above, would have lead to misleading conclusions about the relevance of demand uncertainty in explaining investment decisions.

JEL codes: E220, D810, C230.
Keywords: planned investments, demand uncertainty, survey data, panel estimation.

Contents

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1. Introduction [1]

In the last thirty years, debate about the investment-uncertainty relationship has flourished. The reason for such interest lies primarily in the difficulty of deriving unequivocal conclusions about the sign and relevance of this relationship.

According to Hartman (1972) and Abel (1983, 1985) the effect of uncertainty on investment decisions is positive, or at least non-negative, for firms operating under perfect competition, with a constant return to scale (CRS) technology and a symmetric adjustment-cost function for capital. With the additional assumption of costlessly adjustable labour input, it can be shown that the marginal value of capital is a convex function of prices. In a stochastic context, an increase in uncertainty raises the value of investment, and therefore of investment expenditure, irrespective of the assumption on the investment-cost function.

Following the analyses of Bernanke (1983) and Mc Donald and Siegel (1986), Bertola (1988) and Pindyck (1988) demonstrate that in a monopolistic and stochastic setting an increase in uncertainty over the evolution of demand reduces investment via an irreversibility effect. The basic concept is that of the "perpetual call option" value of an investment plan: with greater uncertainty the value of the option to postpone investment increases (in order to wait for new information) so that the decision to invest is delayed. In other words, an irreversible investment entails an opportunity cost increasing with uncertainty.

According to Caballero (1991; see also Abel and Eberly, 1994, 1996, 1997) the crucial hypothesis is not the irreversibility of the capital goods used by the firm, but the hypothesis on the structure of the product market: for a competitive firm with a CRS technology, even under irreversibility of capital goods the Hartmann-Abel approach may prevail, thus generating a non-negative relationship between investment and uncertainty. This is due to the fact that with perfect competition the marginal revenue product of capital does not depend on the capital stock: current investment thus has no effect on the future profitability of the firm and the firm never has a reason to disinvest. Under imperfect competition the marginal profitability of capital depends on the level of capital via the

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product demand function and given (asymmetrical) irreversibility: '*having too much of capital is "worse" than having too little of it since increasing the stock of capital is cheaper than decreasing it'* (Caballero, 1991, p. 286).

Pindyck (1993), however, shows that the irreversibility effect may nevertheless prevail even for firms adopting a CRS technology and facing perfect competition: in this case it is necessary to consider explicitly the effects of industry-wide demand uncertainty on the equilibrium of a competitive industry (in this context Sakellaris, 1994, shows that the relevant point is the elasticity of demand; more specifically, he shows that the irreversibility effect dominates for firms with an inelastic demand curve; see also Caballero and Pyndick, 1996).

In an attempt to shed light on the ambiguity of the uncertainty effect, Lee and Shin (2000) consider more explicitly the role of labour input. They show that the variability of labour tends to 'convexify' the firm profit function so that uncertainty may raise investment. The intuition of this result is that the variability of one production factor can compensate for the irreversibility of the other (see also Eberly and Van Mieghem, 1997).

Even from this very concise overview of the literature it appears that the shape of the investment-uncertainty relationship depends crucially on the interplay of the different hypotheses about the degree of competition in the product market and the technological characteristics of the production function and of its inputs.[2] This leaves much room for empirical analysis in measuring the consequences of the assumptions on the features of the firm's capital goods, the elasticity of demand and, more generally, the technology (with particular emphasis on the role of the labour input). This is what we try to do in this paper.

A general result of the empirical literature is that the effect of uncertainty on investment decisions is negative and significant (see Carruth et al., 2000, for a review, and more recently, Greasley and Madsen, 2006). However, as much of the literature is based on aggregate data it is difficult to find a proper assessment of the role played by the different assumptions about firm characteristics. Moreover, even in empirical analyses at micro level (see for example Leahy and Whited, 1996), the absence of suitable data, with information on irreversibility, market power etc., has prevented a much deeper investigation of firms'

[2] This is evident when one considers other contributions based on the analysis of different hypotheses about the investment process, such as the role of investment lags (Bar-Ilan and Strange, 1996); the effects of the cost of expanding the capital stock (Abel et al., 1996); the effects of past investment decisions on current investment (the "hang-over" effect of Abel and Eberly, 1999); the existence of non-linearities in the investment decision process (see Barnett and Sakellaris, 1998; Abel and Eberly, 2002; and Bo and Lensink, 2005).

behaviour (a partial exception is Chirinko and Scaller, 2004, who present estimates of the importance of irreversibility for a panel of American firms).

One of the main problems faced by empirical analyses is the absence of a reliable measure of uncertainty. The great variety of proxies proposed in the literature may at least partly explain the rather inconclusive evidence about the nature of the investment-uncertainty relationship. A possible solution to this problem is to derive a measure of uncertainty directly from entrepreneurs, by exploiting self-reports of expectations elicited in the form of subjective probabilities (see Mansky, 2004, for a theoretical analysis of expectation measurement in economics).

Guiso and Parigi (1996, 1999) were the first to use subjective probabilities to quantify the uncertainty surrounding the expected evolution of demand faced by a firm. Using the rich database of the Survey on Investments in Manufacturing (SIM), conducted annually by the Bank of Italy, they provide evidence on the link between uncertainty and investment and, above all, on the role played by irreversibility and by the degree of competition in the product market. In particular, they show that the uncertainty effect is negative and becomes stronger the higher is the degree of irreversibility and the greater the firm's market power.[3]

However, Guiso and Parigi's empirical investigation is limited to the cross-section dimension and therefore their results may be distorted by the omission of other explanatory variables in both the individual and the time dimension and/or by the possible presence of selection biases in the sub-samples used to assess the effect of uncertainty for high/low reversibility and market power.

These limitations can be circumvented by the use of panel data: in our paper, thanks to the availability of a sample of Italian manufacturing firms observed in the period 1996-2004 (covering a complete business cycle: the expansion from 1996 to 2000 and the recession in the following four years) we can account for unobservable individual differences between firms (such as risk aversion) and for more aggregate (industry-wide and/or macroeconomic) shocks. We also compute some econometric tests for the presence of selection biases in the analysis of the effects of reversibility, market power and labour flexibility. Finally, the availability of panel data allows us to better track the evolution of the uncertainty-investment relationship over time. The estimation in repeated cross-sections reveals a dynamic pattern of the uncertainty parameter estimates, which seem to have a

[3] Patillo (1998) and Lensink et al. (2005) obtain fairly similar results by applying the same approach to a sample of industrial firms in Ghana and in the Netherlands, respectively.

positive trend, and in the last two years of the sample it is not significantly different from zero. This means that the cross-section estimates computed for the initial and final years of the period would have given opposite insights into the investment-uncertainty relationship. Longitudinal data circumvent this problem: they allow us to frame the analysis in the more general dynamic context by exploiting the information about variability over time. We have therefore been able to account properly for the evolution of the Italian manufacturing sector in a period of deep changes at both the institutional and the technological level.

The results of our analysis are twofold: on one side they confirm the previous findings of the empirical literature; on the other, they contain new and original evidence on some characteristics of the investment-uncertainty relationship. In the first case, we show that the link between demand uncertainty and investment decisions is fundamentally negative (a reduction of uncertainty from the third to the first quartile of its distribution implies an increase of 1.3 per cent in investments) and that the effect of uncertainty seems to be stronger for the firms that employ more irreversible capital goods and/or operate in markets with a lower degree of competition.

In the second case, we provide some evidence on the role of the flexibility of labour input and the evolution over time of the investment-uncertainty relationship. We show that the effect of uncertainty on investment plans seem to weaken for firms that can employ a more flexible labour input, a result that is consistent with the theoretical analysis of Eberly and Van Mieghem (1997) and Lee and Shin (2000). Moreover, our findings seem to support the hypothesis that the investment decision process in Italian manufacturing firms has been deeply influenced by the increase in competition during the period under scrutiny.

A number of factors may lie behind this evolution. First, the adoption of the euro has definitely prevented the 'competitive devaluations' of the lira that occurred frequently in the past, helping Italian firms to counteract competition on foreign markets. Second, the fast and contemporaneous development of new industrialized countries (such as China and India) has exerted strong competitive pressures especially in low-technology sectors where Italian firms are traditionally specialized. Third, in the last ten years the functioning of the labour market has been significantly altered to achieve greater flexibility in the use of the labour input. All in all, these events seem to suggest a general shift towards an environment more similar to the stylized model underlying the Hartman-Abel approach.

The paper is organised as follows. Section 2 briefly describes the theoretical model used in the empirical analysis. Section 3 presents the main features of our data and computes preliminary cross-section estimates of the relationship of interest. Section 4 reports baseline estimation results over the full sample and a number of variants to assess their robustness. Section 5 focusses on the estimates of the model in sub-samples selected on the basis of different degrees of irreversibility of the installed capital, of market competition and of labour flexibility. The issue of the stability over time of the parameter estimates is assessed in Section 6, especially in relation to the evolution of the degree of competition (measured by the price-cost margin). Section 7 contains some general comments on the results. In addition, Appendix A1 gives details of data sources, definitions and representativeness, and Appendix A2 reports estimation results using realised instead of planned investments.

2. The model

The empirical model used for estimation is a panel version of that proposed in Guiso and Parigi (1996, 1999) and is based on the idea that investment decision is irreversible and that the demand threshold triggering investment rises with uncertainty. Abel and Eberly (1994, 1996, and 1997) show that the optimal trigger point is equal to the user cost of capital adjusted to account for irreversibility and uncertainty. In particular, uncertainty raises the value of the user cost and so reduces the responsiveness to demand of both the decision to invest and the amount of the investment. Let $mvp = a(K/y)^{-1/\gamma}$ be the marginal value product of capital evaluated at the current level of the stock of capital, K, and of demand y; a is a constant and $0 < \gamma < 1$ a parameter. Let $c(u)$ be the user cost of capital which, under irreversibility, is positively influenced by uncertainty about future demand, u.

With no adjustment costs and ignoring depreciation, the firm's optimal capital stock is $K^* = y(c(u)/a)^{-\gamma}$ and the corresponding investment policy is: $I = K^* - K > 0$ if $mvp > c(u)$ or $K < y(c(u)/a)^{-\gamma}$. When $mvp \leq c(u)$, or $K \geq y(c(u)/a)^{-\gamma}$, investment should be zero. This case is a natural test of the irreversibility theory but it is very difficult to implement because of the extreme rarity of observations with zero investment (lower than 3 per cent of the total number of our observations). This occurs especially when using data on total investment, which is an aggregate of different types of capital goods, such as structures, equipment and so on: firms may plan zero investment in structures as well as positive investment in other categories.[4] However, the virtual absence of zero-investment

[4] Bloom et al. (2003, 2007) studies the irreversibility theory with aggregation effects. Guiso and Parigi (1999) present some estimates for three different types of capital goods, equipment, structures and vehicles, confirming the results obtained for the total aggregate; more recently, Bontempi *et al.* (2004) extend the fundamental q approach to the case of two capital inputs: equipment and structures.

observations should not alter the relationship between uncertainty and the user cost of capital that is at the root of our analysis of investment decisions.

We therefore concentrate on the case $mvp > c(u)$, so that $K^* = y(c(u)/a)^{-\gamma}$. In this context and with panel data, the investment rate can be shown to be a function of demand, uncertainty and the inherited capital stock according to the following empirical equation:

$$(1) \qquad \frac{{}_tI_{it+1}}{K_{it}} = \alpha_i + \lambda_t + \alpha_1 \frac{{}_tY_{it+1}}{K_{it}}\left[1 + \alpha_2 \frac{u\left({}_tY_{it+1}\right)}{K_{it}}\right] + \alpha_3 \frac{I_{it}}{K_{it-1}} + \alpha_4' Z_{it} + \varepsilon_{it+1}$$

where subscripts i and t respectively indicate the i^{th} company (i = 1, 2, …, N) and the year t (t = 1, 2, …, T). K_{it} is the stock of capital measured at the end of t; ${}_tI_{it+1}$ and I_{it} respectively represent the investment planned at year t for the following year and the realised investment in t; ${}_tY_{it+1}$ is the level of demand expected at the end of year t for the following year; $u\left({}_tY_{it+1}\right)$ represents the firm's uncertainty about demand in $t+1$ as perceived in t. All previous variables are measured at constant prices. Z_{it} is a vector of additional controls to account for exceptional events, such as extraordinary operations, and ε_{it+1} is the stochastic error term referring to investment plans in $t+1$. Fixed effects α_i and λ_t refer to firms and time; they account for individual unobservable characteristics influencing the investment-uncertainty relationship and for a degree of dependency over time across companies due to collectively significant effects. Parameters α_1, α_2 and α_3 are scalars, α_4 is a vector. Detailed definitions and data sources are in Appendix A1.

According to the irreversibility literature, the *a priori* sign of α_2 should be negative and significant. However, if the Hartman-Abel set-up applies, α_2 should be positive or not significantly different from zero. The elasticity of investment plans to expected demand and the semi-elasticity of investment plans to the uncertainty can be computed with parameter estimates and a set of alternative statistics of the sample distribution of the variables.

3. The data

Our dataset is constructed from three main sources: the Survey on Investment in Manufacturing (SIM), the Company Accounts Data Service (CADS), and the breakdown by sector of the National Account data (NA). The main source is SIM, annually conducted by the Bank of Italy on a sample of Italian manufacturing firms. By considering the whole sample of firms in the period 1996-2004, the total number of observations is 17,248 (company-year cases). However, the questionnaire for firms with less than 50 employees does not include the section on uncertainty so we are forced to ignore these firms and the non-response cases, ending with a sample of 8,633 observations.

The SIM database is very rich and contains many pieces of original information that cannot be found in other sources. This is the case of investment plans, expected demand and the range between its minimum and maximum growth rate expected one year ahead (henceforth, the min-max range); questions about liquidity constraints; some information on the characteristics of the second-hand market for capital goods, and so on (regarding the SIM database, see Banca d'Italia, 2006).

To compute a proxy for uncertainty we use the min-max range of the expected growth rate of demand. Let ${}_t g_{it+1}$ be the growth rate of the i^{th} company's demand at constant prices for $t+1$ as perceived in t and SAL_{it} the value at current prices of the i^{th} company's sales in t; both variables can be found in the SIM. The expected one-year-ahead level of sales at constant prices is ${}_tY_{it+1} = \left(1+{}_t g_{it+1}\right) Y_{it}$, where $Y_{it} = \dfrac{SAL_{it}}{PY_{it}}$ and PY_{it} is the individual sales' deflator, both from SIM.[5] If we define the uncertainty about the future demand growth rate $u\left({}_t g_{it+1}\right)$ as the min-max range of the expected growth rate at constant prices reported by the SIM respondents, we obtain the following definition of uncertainty:

$$(2) \qquad u\left({}_tY_{it+1}\right) = u\left({}_t g_{it+1}\right) Y_{it} = \left({}_t g^{max}_{it+1} - {}_t g^{min}_{it+1}\right) Y_{it}$$

The proxy of uncertainty in (2) simplifies that used by Guiso and Parigi, who exploit a part of the questionnaire where respondents were asked, *una tantum* in 1993, to report their whole probability distribution of the expected growth rate of demand. Any comparison between the two measures is not possible as they are not simultaneously available for the same time period. Definition (2) has a number of advantages, however, because it provides time-series data (for all the years in the 1996-2004 period) and it is a simple question, thereby limiting the presence of errors in the reports.[6]

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[5] Individual sales' deflators are obtained by applying the SIM growth rate for year *t* to the previous year NA deflator level of the sector to which the firm belongs. We directly use NA sectoral deflator levels when SIM growth rates are not available.

[6] Since not all firms with more than 49 employees report the min-max range, we run a probit regression of non-response probability against time dummies and a set of observable characteristics, such as industry, location, type of ownership, size, and share of exported production (see Appendix 1.3 for more details). The only significant effect concerns public and large firms, which are less likely to report the min-max range, hopefully because the respondents are not close enough to the top management to provide a suitable answer. Therefore, the loss of information due to non-responses should prevent large measurement errors for the min-max range.

The SIM database is far from being complete for the aims of the present study as it doe not contain some relevant variables, such as the capital stock, the cash flow, and other information to compute the price-to-cost margin. These pieces of information can be found in the CADS database, however. After merging the two datasets, the total number of available observations for the empirical analysis drops to 7,642, our final base-sample.[7]

Notwithstanding the loss of observations due to the different choices and to the merging operations described above, the final sample is a fairly satisfactory representation of the composition of Italian manufacturing firms by size, manufacturing sector and geographical location (see Table A1.1 in Appendix A1).

A preliminary step of our empirical analysis is the estimation equation (1) in repeated cross-sections, i.e. one for each year from 1996 to 2004. This allows us to have a set of results that can be compared with those found in most of the empirical literature and at the same time to provide some evidence about the evolution over time of the parameter estimates. As the cross-section specification of equation (1) does not allow us to estimate the fixed company effects α_i, we try to compensate for their exclusion by including in the Z-vector a set of time-invariant dummy variables to proxy for the firm's unobservable heterogeneity in technology, market structure, and management tastes.[8] The time effects λ_t are proxied by the intercept of equation (1), whose estimates are allowed to change in repeated cross-sections.

Figure 1 reports the time path of the estimated elasticity of planned investments to the expected demand, and of the α_2 parameter estimates; the dotted lines are the corresponding 90 per cent confidence intervals. Point estimates are often at least 10 per cent significant (the elasticity of investment to demand lies in the 0.2-0.4 range, and the estimate of α_2 is always negative), and decrease in absolute value over time. The α_2 estimates, however, lose their significance in the last two years of the sample.

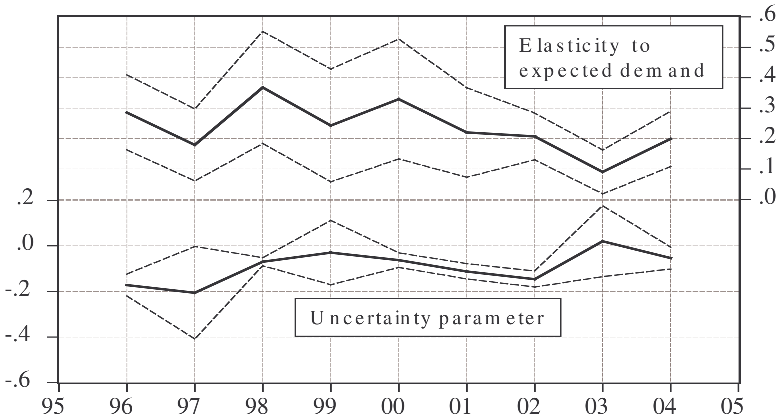
The last point suggests that, if we had had only (cross-section) data for a single year in the second half of the sample, we would have probably estimated a low and scarcely significant effect of uncertainty on investments, and a low elasticity of planned investments to expected demand. The opposite would have occurred if we had had only cross-section data for a single year in the first half of the sample, as in Guiso and Parigi (1999).

[7] Sectoral NA data are the source of depreciation rates and are also used to deflate nominal variables when SIM prices are missing. Appendix A1 contains detailed definitions of our variables of interest.

[8] These dummy variables refer to industry, location, size, type of ownership, merger-acquisition operations, and zero cases of both effective investment and planned demand (see Appendix A1.3).

Figure 1

EXPECTED DEMAND AND UNCERTAINTY EFFECTS ON INVESTMENT: REPEATED CROSS-SECTION ESTIMATES [1]



([1]) The dotted lines delimit the corresponding 90 per cent confidence intervals.

4. Baseline estimates and robustness checks

The information about the companies in our sample may be better exploited using the two-way panel approach, i.e. by estimating equation (1) with fixed individual and time effects.[9] In this way, we can avoid the biases due to the omission of unobservable time-invariant individual effects, such as the entrepreneur's risk aversion, and of collectively significant macroeconomic effects (hence almost invariant for all companies), such as industry-wide shocks, macroeconomic cyclical effects, widespread optimism-pessimism, or risk aversion shifts over time. A major feature of the specification of equation (1) is that it is not dynamic. In fact, the explanatory variable $\frac{I_{it}}{K_{it-1}}$ differs from the one-year lagged dependent variable, that is $\frac{{}_{t-1}I_{it}}{K_{it-1}}$, because of the large discrepancies between *ex ante* plans and *ex post* realisations due to shocks and news affecting the company's behaviour after plans are made (see Appendix A2). In this context the demeaning of the variables (the 'within transformation') to account for fixed effects does not necessarily entail the endogeneity of $\frac{I_{it}}{K_{it-1}}$, as it would in a truly dynamic model. Therefore, equation (1) parameters can be estimated by applying ordinary least squares (OLS) to within-transformed

[9] The alternative random individual effects estimator is prone to be biased by the correlation between individual effects and the explanatory variables. Therefore we prefer, as usual in the literature, to rely on the at least consistent fixed effects estimator, as suggested by the outcome of the Hausman (1978) specification test.

data (however, the OLS-within estimates are also compared with those obtained with a suitable GMM estimator for dynamic panels). Parameter standard errors are always adjusted to account for generic heteroskedasticity (see White, 1980); hereafter, we will refer to them as "robust" standard errors.

Table 1

PLANNED INVESTMENTS AND UNCERTAINTY: EQUATION (1) ESTIMATES AND DIAGNOSTICS [1]

Regressors[2]	(1)	(2)	(3)	(4)	(5)	(6)
$\frac{{}_tY_{it+1}}{K_{it}}$	0.0301 (0.0125)	0.0312 (0.0131)	0.0276 (0.0121)	0.0308 (0.0128)	0.0301 (0.0136)	0.0128 (0.0067)
$\frac{u\left({}_tY_{it+1}\right)}{K_{it}}$	-0.0318 (0.0139)	-0.0321 (0.0137)		-0.0320 (0.0137)	-0.0144 (0.0093)	-0.0388 (0.0196)
$\frac{I_{it}}{K_{it-1}}$	0.0284 (0.0513)	0.0286 (0.0510)	0.0293 (0.0515)	0.0280 (0.0513)	0.0091 (0.0536)	0.1198 (0.0315)
$\frac{{}_tY^2_{it+1}}{K_{it}}$		-7.99E-09 (5.01E-09)				
$u\left({}_t g_{it+1}\right)$ (3)		0.0491 (0.0369)				
$\frac{u\left({}_tY_{it+1}\right)^2}{K_{it}}$			-0.0931 (0.0516)			
RAT_{it} (4)				0.0020 (0.0180)	0.0103 (0.0175)	
$\frac{CF_{it}}{K_{it-1}}$ (5)					0.0004 (0.0142)	
N×T	7642	7642	7642	7547	7060	7642
N	2141	2141	2141	2134	2078	2141
$\overline{T}$	3.57	3.57	3.57	3.54	3.40	3.57
RMSE	0.1807	0.2128	0.1810	0.1810	0.1797	-
R^2	0.1284	0.1309	0.1249	0.1304	0.1319	0.0719 [6]

([1]) Robust standard errors are in brackets. ([2]) Specification of equation (1) unless otherwise indicated. ([3]) Variability of the real, expected demand growth rate one-year-ahead. ([4]) Dummy equal to 1 for credit-rationed firms, see Appendix A1.3. ([5]) Cash flow over capital stock, see Appendix A1.3. ([6]) Calculated as the squared correlation of actual-fitted data.

Table 1 reports parameter estimates and robust standard errors for six variants of the equation (1) specification obtained using all the available data: an unbalanced panel of 2,141 companies (the number of time observations for each company ranges from 1 to 9 years, with an average of 3.57 years). The sample dimension is not constant across different columns depending on the specific regressors used in the alternatives.

The first column of Table 1 reports the estimates of equation (1). The level of expected demand has a positive and significant effect on investment plans (α_1): evaluated at the sample medians of expected demand and of uncertainty, the planned investments' elasticity to expected demand is not different from unity; it halves when evaluated at the first quartile of demand and doubles with the third quartile (point estimates and robust standard errors are reported in the lower part of column 1 of Table 2).

Demand uncertainty, interacted with the expected demand, has a significantly negative effect on investment plans (α_2), as predicted by investment models based on irreversibility. Evaluated at sample medians, the elimination of demand uncertainty would increase the investments planned for the following year by 0.8 per cent (1.3 when uncertainty is reduced from the third to the first quartile of the sample distribution; see the lower part of column 1 of Table 2).

It could be argued that the interaction between uncertainty and expected demand in equation (1) may actually be capturing a second-order term in the Taylor approximation of a non-linear relationship between investment plans and expected demand. Furthermore, it could be that uncertainty on one-year-ahead demand growth also has an additional direct (*i.e.* not passing through demand dampening) effect on investments. To check for these additional effects, results in the second column of Table 1 report the estimates of a specification where the squared expected demand (scaled by capital stock) and our uncertainty measure (the min-max range of demand growth) are added to equation (1). The sign and the significance of the parameters of these additional regressors may be respectively interpreted as evidence of non-linearity in the relationship between investment plans and expected demand, and the net impact effect on planned investments of various levels of uncertainty. None of these variable-additions is statistically significant, while the other parameter estimates remain virtually unchanged.[10] This result suggests that, in our case, neither non-linear nor uncertainty-level effects are relevant explanations of investments, while α_2 parameter captures the cautionary effects of uncertainty..

Another possible objection to the specification of equation (1) is that the negative effect of uncertainty on investment arises because it actually proxies for credit constraints: if credit constraints are due to the company's inherent riskiness, riskier firms may be more liquidity-constrained and so plan less investment. This interpretation is assessed in column

[10] The joint hypothesis that the estimates of the two extra coefficients in column (3) are equal to zero is accepted (p-value=18 per cent). A similar result is obtained if we add the two variables one at a time to equation (1).

(4) by adding the RAT_{it} variable to equation (1). *RAT* is a dummy equal to one if the i^{th} firm at time *t* was rationed in the credit market, on the basis of the SIM replies to the questions on credit applications (see Appendix A1.3). In column (5) we follow Fazzari, et al. (1988) by adding, besides the RAT_{it} indicator, a measure of the firm's cash flow net of dividend paid, CF_{it}, to proxy for liquidity constraints (see Appendix A1.3). The parameter estimates of these two variables are largely not significant, both individually (t-statistics are smaller than 0.5) and jointly (the p-value of the test is 0.842), while the other parameter estimates rarely depart from the corresponding ones in column (1).

In column (6) of Table 1 we estimated equation (1) with GMM-sys (see Blundell and Bond, 1998) in order to assess for the robustness of our OLS-within estimates to possible measurement errors and endogeneity due to dynamics, as discussed above. The GMM-sys estimator is more general than other alternatives (it also allows us to instrument explanatory variables' levels with first differences) and preserves the sample dimension while the alternative approach of Arellano and Bond (1991) based on first differences would have implied a loss of 2,920 observations out of 7,642. GMM-sys is carried out using as instruments the theoretical determinants of uncertainty (reversibility and market power indicators, see Appendix A1.3) and lags of both effective and expected data on investments and sales. In the light of the Hansen (1982) *J* test, the 602 over-identification restrictions are not 5 per cent rejected and the Arellano and Bond (1991) test does not detect any signal of autocorrelation of residuals. Estimation results in column (6) are in line with our base findings: the effects of interest are significant and the estimation intervals overlap those in column (1). For this reason, in what follows we will only refer to the OLS-within estimates.

Finally, we have substituted the dependent variable, investment plans, with the realised investment reported by the companies (a thorough description of this exercise is in Appendix A2). In this case we expect to obtain less significant parameter estimates, as realised investment may have been driven by news that changed the initial plans of the firms. This is indeed what we find with the GMM-sys estimator as equation (1) with realised, instead of planned, data is a genuine dynamic panel model. Moreover, when we add to the modified equation (1) the company investment plans, all other parameters lose their significance, indicating that investment plans can be considered sufficient statistics for realised investment.

Overall, panel estimates seem to confirm qualitatively the cross-section results: investment plans are directly linked to expected demand, and the effect of uncertainty appears to be negative and significant even after a series of robustness checks. However, from a quantitative point of view, some differences appear regarding the value of the elasticity to expected demand, as also shown by our repeated cross-section estimates.

5. The effect of uncertainty in sub-samples

The empirical analysis of the influence of different theoretical hypotheses, such as the irreversibility degree of capital goods, market power of firms and flexibility of the labour input, is performed by splitting the sample of firms according to some indicator s_{it} (usually equal to one if the observation is included in the sub-sample of interest, zero otherwise), supposed to be a good proxy of the phenomenon under scrutiny (for example, price-cost margin is used as an indicator of firms' market power). Given that these indicators may not be exogenous for the problem at hand, there is the risk that the parameter estimates in the different sub-samples may be biased because of the endogeneity of the selection rule determining the indicator. More specifically, a selection problem occurs if the probability of being included in a sub-sample of interest is related to the dependent variable (i.e. the outcome s_{it} of the selection indicator is simultaneous with the investment plans' idiosyncratic shock ε_{it+1}). Therefore, changes in fixed-effects estimates in different sub-samples indicate genuine parameter changes (and not bias) only if we can exclude such simultaneity by accounting for the non-random nature of the sub-samples.

In this context, tests for sample selection bias are constructed on the basis of a null hypothesis that the selection rule can be ignored for the estimates of equation (1), while the alternative implies a bias due to endogenous selectivity. With fixed-effects estimation techniques, implementations of tests for selection bias are straightforward by testing the significance of additional variables. In this Section we use two different tests: one uses either s_{it-1} or s_{it+1} as an auxiliary regressor in equation (1) (see Nijman and Verbeek, 1992); the other adds to equation (1) the inverse Mills ratio from a pooled probit regression for the selection indicator s_{it} (see Wooldridge, 1995).[11] The first approach has the main advantage of avoiding the estimation of an explicit model for the selection rule and, as such, is not

[11] In order to ensure structural parameter identification, the explanatory variables of the probit models include several regressors besides the expected demand, uncertainty and realised investments (i.e. the main equation (1) regressors): dummy variables for a set of observable characteristics (such as industry, location, type of ownership, size, and share of exported production) and one-lag of the price-cost margin, of the labour turnover and the overtime index depending on the selection rule being modelled.

subject to relevant mis-specification errors. However, it does not work if s_{it} is constant by firm in the selected sub-sample.

It is worth observing that the problem of selection bias cannot be tackled in a pure cross-section context, as in Guiso and Parigi (1999). The results shown below may therefore be considered an extension of their analysis. In all the estimates presented in this Section we do not reject the null of exogenous selection (in each table the corresponding p-values are reported together with model parameter estimates) and can safely conclude that the selection bias problem may not be so relevant for our analysis. This outcome may be due, among other, to the low number of 0-1 switches in s_{it} by firm. The latter point is stressed by considering the estimation results related to the firms that always remain in the same sub-sample or at most switch once in five years.

5.1 Irreversibility and market power

In the irreversibility theory of investment the negative effects of uncertainty arise from the difficulty of liquidating installed capital when demand proves to be lower than expected. However, according to Caballero (1991) the presence of irreversibility is not sufficient to render a negative relationship between investment and uncertainty: some degree of imperfect competition is the crucial determinant. In this paragraph we test both the hypotheses of irreversibility and the degree of competition and a combination of the two. The results seem to confirm Caballero's suggestion: the negative effect of uncertainty appears to be stronger for irreversible firms with a higher degree of market power.

To quantify the influence of irreversibility, we split our full sample in two parts according to a reversibility indicator obtained on the basis of the SIM information about transactions in the secondary market for capital goods and about leasing investment (see Appendix A1.3). This indicator captures to a certain extent the reversibility of investment decisions because it takes into account the "putty/putty" feature of the technology used by the firm. In this context, we may compute two reversibility indicators: a "strong" and a "weak" one. The strong indicator is obtained on the basis of single cases (company-year): reversibility occurs when the i^{th} company at time t explicitly uses the opportunity to buy in the second-hand and/or in the leasing markets. In this case a single company may belong in some years to the "high reversibility" group and in others to the "low reversibility" one. The weak indicator is based on all the cases relating to the same company. In particular, a company is classified in the "high reversibility" group if it uses the opportunity to buy in the second-hand and/or in the leasing markets at least twice during the sample period.

Table 2 (columns 2 to 5) shows the results of the estimates of equation (1) by splitting the sample according to the high or low reversibility groups (column 1 replicates the first column of Table 1 to ease comparisons). The estimates of the uncertainty parameter are lower (in absolute value) and not significant for the sub-sample characterised by a high degree of reversibility. Vice versa, in the sub-sample of the companies with a low degree of reversibility, the estimates of the uncertainty parameter are higher in absolute value and largely significant. In this case the uncertainty effect on investment plans is almost four times as high as that for the companies with a higher degree of reversibility.

The characteristics of the product market may be analyzed through the degree of market power of a company. This can be measured on the basis of the deviations of the company's price-cost margin with respect the median of the industrial sector to which it belongs (results do not change if the mean is used).[12] The price-cost margin is computed according to Domowitz et al. (1986; see Appendix A1.3). With this indicator we can classify the companies in our sample into two sub-samples according to the "low" or "high" degree of their market power. In Table 2 (columns 6 to 11) the estimates of equation (1) for the sub-samples relating to the market power show that the uncertainty effect is stronger for firms operating in markets with a low degree of competition: in column (6) the effect of $\frac{u\left({}_tY_{it+1}\right)}{K_{it}}$ is significant and stronger than that of the total sample, while for the companies belonging to the low market power group, it is very low and not significant (column 9). Again, as in the irreversibility case, the prediction of the theory appears to be confirmed.

As the price-cost margin is only a proxy of the real market power of a company or of the degree of competition in the product market, we consider a further specification linked to the presence of the Italian firms on foreign markets.

On one hand, it is possible that companies which sell a significant share of their products abroad have faced tougher competition in the last ten years. The adoption of the euro put an end to the practice of 'competitive devaluations' of the lira and the contemporaneous development of new industrialized countries has hit the so-called "made in Italy" products particularly hard.

[12] See Martin (1984) for a discussion of the problems of using the price-cost margins as indicator of market power**.** Similar results regarding the effects of competition on the investment-uncertainty relationship have been found in Bulan (2005) and in Bulan et al. (2006), where the degree of competition is proxied by the concentration index and by the number of competitors of the firm, respectively. By measuring competition with the degree of seller concentration, Ghosal and Loungani (1996) find the opposite result (*i.e.* the negative effect of uncertainty is stronger in more competitive industries).

On the other hand, this does not mean that more domestically oriented firms have not experienced an increase in competition. Moreover, it has been argued that many export-oriented firms have been able to exploit specific market niches where their highly specialised products may shelter them from competitive pressures.

These two competing interpretations can be empirically evaluated by considering explicitly the export propensity of the firms in our data set. More specifically, we construct two more sub-samples for both the "high" and the "low" market power cases according to whether the export shares of the companies are greater or lower than 50 per cent (we have also tried with different share intervals with no substantial difference).

The results in Table 2 show that for the companies in the high market power group which sell more on the domestic market the coefficient estimate of uncertainty in column (8) doubles, implying an even greater market power. On the contrary, for the companies with an export share greater than 50 per cent the uncertainty effect in column (7), though significant, appears to be weaker than in the total sample estimates. By considering the firms with an export share below 50 per cent in the low market power group, the estimated coefficient of uncertainty in column (11) is significant and close to the one estimated for the total sample.

The final step in this paragraph is to combine the irreversibility and the "high" market power groups. For reversibility, we have chosen to concentrate only on the classification based on the 'weak' indicator, which appears to be more robust than the 'strong' one as it is based on the behaviour of firms over the whole time period and not only on single events. Columns (12) and (13) of Table 2 report the estimates for the sub-sample of the companies classified as both 'high market power' and 'low reversibility', and the sub-sample of the companies classified both as "low market power" and "high reversibility", respectively. Confirming our *a priori*, the uncertainty parameter estimates appear to be higher in absolute value in the group where firms use more irreversible capital goods and are more likely to face less competition, while it is almost negligible in the other group. The effect on investment plans is almost twice as strong as that of the firms in the second group.

5.2 Labour flexibility

The theoretical literature on the investment-uncertainty relationship has generally ignored the characteristics of the labour input in the investment decision process.

Table 2

PLANNED INVESTMENTS, REVERSIBILITY AND MARKET POWER [1]

		Reversibility				Market power							
	Total sample	Low		High		High			low			Low reversibility and high market power	High reversibility and low market power
		Weak indicator	Strong indicator	Weak indicator	Strong indicator	All cases	With export share >50%	With export share <50%	All cases	With export share >50%	With export share <50%		
Regressors	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
$\frac{{}_tY_{it+1}}{K_{it}}$	0.0301	0.0452	0.0573	0.0181	0.0181	0.0226	0.0320	0.0244	0.0422	0.0888	0.0157	0.0120	0.0221
	(0.0125)	(0.0307)	(0.0284)	(0.0034)	(0.0043)	(0.0060)	(0.0104)	(0.0104)	(0.0256)	(0.0522)	(0.0065)	(0.0062)	(0.0049)
$\frac{u({}_tY_{it+1})}{K_{it}}$	-0.0318	-0.0368	-0.0376	-0.0206	-0.0299	-0.0493	-0.0255	-0.1173	-0.0157	-0.0180	-0.0306	-0.0571	-0.0169
	(0.0139)	(0.0143)	(0.0135)	(0.0148)	(0.0149)	(0.0215)	(0.0121)	(0.0283)	(0.0085)	(0.0176)	(0.0095)	(0.0339)	(0.0121)
$\frac{I_{it}}{K_{it-1}}$	0.0284	0.0615	-0.0003	0.0001	-0.0197	-0.0898	-0.0692	-0.0864	0.0591	0.0065	0.1017	0.0327	0.0524
	(0.0513)	(0.1139)	(0.1241)	(0.0390)	(0.0584)	(0.0911)	(0.0895)	(0.1420)	(0.0822)	(0.2293)	(0.0572)	((0.0456)	(0.0270)
N×T	7642	2353	2525	5289	5117	3549	1254	2295	3555	1175	2380	1007	2377
N	2141	1000	1264	1141	1730	1322	442	880	1400	444	956	529	775
$\overline{T}$	3.57	2.35	2.00	4.64	2.96	2.68	2.84	2.61	2.54	2.65	2.49	1.90	3.07
RMSE	0.1807	0.2443	0.1871	0.1401	0.1310	0.1396	0.1565	0.1288	0.1974	0.2560	0.1311	0.1944	0.1202
R^2	0.1284	0.1827	0.2264	0.1013	0.1101	0.1128	0.1409	0.1069	0.1900	0.3852	0.1315	0.0825	0.1166
Sample selection bias tests [2]	-	-	0.463	-	0.194	0.928	0.757	0.322	0.973	0.299	0.406	0.676	0.346
	-	0.190	0.761	0.295	0.037	0.455	0.709	0.905	0.433	0.555	0.049	0.669	0.054
ELASTICITY OF PLANNED INVESTMENTS TO EXPECTED DEMAND (evaluated at median uncertainty)													
Median (Q2)	1.062	1.594	2.023	0.640	0.640	0.794	1.134	0.845	1.497	3.147	0.554	0.423	0.784
	(0.444)	(1.087)	(1.001)	(0.120)	(0.152)	(0.212)	(0.370)	(0.360)	(0.908)	(1.845)	(0.231)	(0.219)	(0.172)
% CHANGE OF INVESTMENTS FROM A REDUCTION IN UNCERTAINTY (evaluated at median demand)													
from Q3 to Q1	1.300	2.262	2.932	0.508	0.738	1.515	1.112	3.898	0.905	2.172	0.653	0.936	0.510
	(0.677)	(1.560)	(1.766)	(0.393)	(0.421)	(0.640)	(0.362)	(2.138)	(0.855)	(2.968)	(0.298)	(0.395)	(0.391)

([1]) Regressions with heteroskedastic-consistent standard errors (in brackets). ([2]) P-values of the tests for sample selection bias due to Nijman and Verbeek (1992) in the row above, and to Wooldridge (1995) in the row below.

In most analyses the labour input is optimized out under the assumption of costless adjustment. Only Lee and Shin (2000) take explicitly into account the role of this production factor in the investment decision. Their results show that more can be understood about the investment-uncertainty relationship by explicitly considering the flexibility of the labour input. In particular, the uncertainty effect should be weaker (stronger) for companies with a higher (lower) labour share.[13]

Table 3

PLANNED INVESTMENTS, UNCERTAINTY AND LABOUR FLEXIBILITY [1]

Regressors	Total sample 1996-2004	Turnover		Sub-sample 1998-2004	Overtime – CIG		Low turnover and overtime-CIG	High turnover and overtime-CIG
		Low	High		Low	High		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\frac{{}_tY_{it+1}}{K_{it}}$	0.0301 (0.0125)	0.0188 (0.0076)	0.0445 (0.0251)	0.0333 (0.0162)	0.0126 (0.0056)	0.1031 (0.0438)	0.0150 (0.0111)	0.1404 (0.0618)
$\frac{u\left({}_tY_{it+1}\right)}{K_{it}}$	-0.0318 (0.0139)	-0.0673 (0.0241)	-0.0151 (0.0105)	-0.0313 (0.0149)	-0.0690 (0.023)	-0.0173 (0.0111)	-0.0865 (0.0376)	-0.0176 (0.0158)
$\frac{I_{it}}{K_{it-1}}$	0.0284 (0.0513)	0.0199 (0.0426)	0.1087 (0.0486)	-0.0137 (0.0633)	0.0653 (0.0631)	-0.0327 (0.0843)	0.0580 (0.1081)	0.2495 (0.1680)
N×T	7642	3867	3775	6365	3414	2951	1781	1501
N	2141	1477	1560	2008	1397	1278	895	865
$\overline{T}$	3.57	2.62	2.42	3.17	2.44	2.31	1.99	1.74
RMSE	0.1807	0.1300	0.1912	0.1846	0.1275	0.1911	0.1318	0.1917
R^2	0.1284	0.1089	0.1933	0.1388	0.1101	0.3802	0.1213	0.5548
Sample selection bias tests [2]	- -	0.439 0.311	0.552 0.772	- -	0.526 0.970	0.498 0.405	0.894 0.760	0.506 0.404
ELASTICITY OF PLANNED INVESTMENTS TO EXPECTED DEMAND (evaluated at median uncertainty)								
Median (Q2)	1.062 (0.444)	0.660 (0.268)	1.578 (0.893)	1.179 (0.574)	0.442 (0.198)	3.657 (1.554)	0.522 (0.390)	4.980 (2.189)
% CHANGE OF INVESTMENTS FROM A REDUCTION IN UNCERTAINTY (evaluated at median demand)								
from Q3 to Q1	1.300 (0.678)	1.726 (0.895)	0.917 (0.742)	1.422 (0.793)	1.186 (0.631)	2.431 (1.790)	1.763 (1.222)	3.370 (3.513)

The footnotes ([1]) and ([2]) are the same as in Table 2.

[13] The increase in the labour share is directly linked to the flexibility of the labour input. Eberly and Van Mieghen (1997) show that when a production factor is more flexible it is more exploited than other more rigid inputs so that its share increases.

This implication of Lee and Shin's analysis can be empirically tested in the context of our analysis. The data set of the SIM contains useful information on several features of the labour input used by the companies in the sample, such as the amount of hired and fired workers over the year, the total number of hours worked, of overtime hours and of hours in the wage supplementation fund (CIG, from *Cassa Integrazione e Guadagni*).

On the basis of this information we can compute two indicators of labour flexibility. The first is a measure of workers' turnover (*WT*), defined as the sum of the number of hired and fired employees divided by the stock of total employment in the year. The second measure (*WH*) is given by sum of the total number of overtime and CIG hours divided by the total number of hours worked. As the data about overtime hours have been collected since 1998, all the regressions involving *WH* concern only the 1998-2004 sub-sample period (see Appendix A1.3). As in the irreversibility and market power exercises, the i^{th} firm is classified as belonging to the high (low) labour flexibility group if WT_{it} or WH_{it} is higher (lower) than the corresponding median values in t of the sector to which the firm belongs.

Table 3 reports the estimates of equation (1) for the full sample (column 1) and the 1998-2004 sub-period (column 4). The results seem to confirm Lee and Shin's (2000) analysis: investment plans of firms with high labour flexibility (columns 3 and 6) are considerably less influenced by uncertainty about future demand. The reverse is true for firms with low labour flexibility (columns 2 and 5): in this case the elasticity of investment plans with respect to expected demand is less than half that for firms with high labour flexibility.

The two indicators we have computed may be interpreted as a proxy of two different forms of flexibility, related to the possibility of changing the number of employees (*WT*) or the number of hours worked according to the needs of production (*WH*). It may therefore be useful to consider a third case, in which the high (low) flexibility group is defined simultaneously according to both indicators. The results of this splitting (columns 7 and 8) show that for the companies with a very flexible labour input the effect of uncertainty continues to be non-significant, while it attains its maximum (negative) value in the opposite case (this result could be even stronger if we consider that some firms may have been classified among the low flexibility group because they have chosen not to exploit the potential flexibility of their labour input).

As a final step we check the results for the group of companies selected according to their labour flexibility and degree of market power. The estimates of our specification in these different cases are shown in Table 4.

Table 4

PLANNED INVESTMENTS, LABOUR FLEXIBILITY AND MARKET POWER [1]

		Labour flexibility					
	Total sample	High			Low		
		All cases	Market power		All cases	Market power	
			High	Low		High	Low
Regressors	(1)	(2)	(3)	(4)	(5)	(6)	(7)
$\frac{{}_tY_{it+1}}{K_{it}}$	0.0301	0.0445	0.0161	0.0776	0.0188	0.0719	0.0086
	(0.0125)	(0.0251)	(0.0063)	(0.0486)	(0.0076)	(0.0170)	(0.0058)
$\frac{u\left({}_tY_{it+1}\right)}{K_{it}}$	-0.0318	-0.0151	-0.0536	-0.0215	-0.0673	-0.0707	-0.0283
	(0.0139)	(0.0105)	(0.0262)	(0.0095)	(0.0241)	(0.0345)	(0.0272)
$\frac{I_{it}}{K_{it-1}}$	0.0284	0.1087	-0.0467	0.1223	0.0199	-0.0252	0.0239
	(0.0513)	(0.0486)	(0.0910)	(0.0567)	(0.0426)	(0.0705)	(0.0300)
N×T	7642	3775	1678	1820	3867	1871	1735
N	2141	1560	847	957	1477	884	865
$\overline{T}$	3.57	2.42	1.98	1.90	2.62	2.12	2.01
RMSE	0.1807	0.1912	0.1104	0.2208	0.1300	0.1186	0.0947
R^2	0.1284	0.1933	0.1285	0.3314	0.1089	0.2106	0.0709
Sample selection bias tests [2]	-	0.552	0.269	0.753	0.439	0.428	0.336
	-	0.772	0.454	0.724	0.311	0.931	0.738
ELASTICITY OF PLANNED INVESTMENTS TO EXPECTED DEMAND (evaluated at median uncertainty)							
Median (Q2)	1.062	1.578	0.565	2.750	0.660	2.518	0.304
	(0.444)	(0.893)	(0.224)	(1.722)	(0.268)	(0.593)	(0.208)
% CHANGE OF INVESTMENTS FROM TO A REDUCTION IN UNCERTAINTY (evaluated at median demand)							
From Q3 to Q1	1.300	0.917	1.173	2.273	1.726	6.929	0.332
	(0.677)	(0.742)	(0.541)	(1.878)	(0.895)	(3.876)	(0.264)

The footnotes ([1]) and ([2]) are the same as in Table 2.

The general impression is that the market power characteristic tends to dominate that of labour flexibility. This is fairly clear in columns (3) and (7), in which the explicit consideration of market power completely offsets the results obtained previously for labour flexibility; in the remaining two cases (columns 4 and 6) the estimates confirm and reinforce those already obtained when only market power was used (see Table 2, columns 6 and 9). This set of results seems to suggest that the information content of our measures of labour flexibility is somehow accounted for by the degree of market power. More evidence on this point will be provided in the next Section.

6. The effect of uncertainty over time

The time dimension of our dataset allows us to conduct an analysis of the investment-uncertainty relationship over time. The evidence provided by the repeated cross-section estimates in Section 3 (especially the evolution of the estimated coefficient of uncertainty in Figure 1) may be interpreted as a sign of instability affecting our panel results. This implies the presence of a break in the parameter estimates of equation (1).

As the exact timing of the break is not known, we test for the stability of parameters α_1 α_2 α_3 by computing repeated Chow tests in the 1999-2003 period. More specifically, five regressions of equation (1) are computed, where we add interaction terms between the three regressors - i.e. expected demand, uncertainty and lagged realised investments - and step dummies D_τ (equal to zero before τ, 1 afterwards, with τ ranging from 1999 to 2003).

Table 5

STABILITY OF PARAMETERS OVER TIME [1, 2]

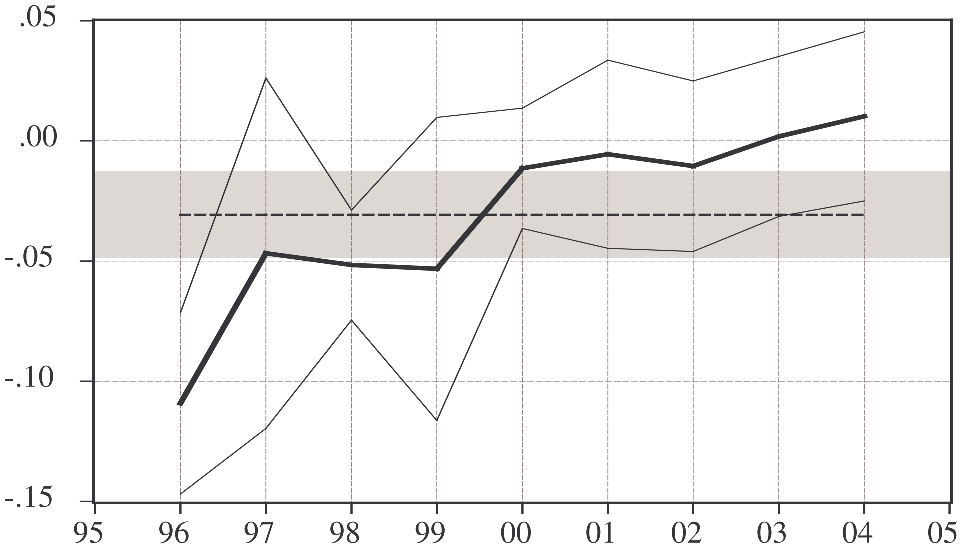
	(1)	(2)	(3)	(4)	(5)	(6)
Break:	no	in 1999	In 2000	in 2001	in 2002	in 2003
model parameters [3]:						
α_1	0.0301	0.0262	0.0273	0.0265	0.0291	0.0319
	(0.0125)	(0.0094)	(0.0098)	(0.0096)	(0.0122)	(0.0133)
α_2	-0.0318	-0.0490	-0.0510	-0.0450	-0.0400	-0.0350
	(0.0139)	(0.0170)	(0.0160)	(0.0170)	(0.0130)	(0.0150)
α_3	0.0284	0.1118	0.0964	0.1097	0.0904	0.0203
	(0.0513)	(0.0590)	(0.0425)	(0.0425)	(0.0339)	(0.0547)
α'_1		0.0070	0.0072	0.0064	-0.0031	0.0004
		(0.0064)	(0.0070)	(0.0074)	(0.0037)	(0.0036)
α'_2		0.0430	0.0410	0.0330	0.0370	0.0320
		(0.0190)	(0.0170)	(0.0180)	(0.0190)	(0.0200)
α'_3		-0.1213	-0.1348	-0.2116	-0.2475	0.1369
		(0.0824)	(0.0892)	(0.1042)	(0.1397)	(0.1000)
RMSE	0.1807	0.1787	0.1783	0.1779	0.1786	0.1802
R^2	0.1284	0.1479	0.1515	0.1557	0.1485	0.1333
Parameter constancy test:[4]						
F statistic		1.726	1.732	1.785	2.110	1.465
Degrees of freedom		3	3	3	3	3
P-value		0.1594	0.1582	0.1477	0.0968	0.2219

([1]) Robust standard errors in brackets. ([2]) The dimension of the sample is 7,642 observations for 2,141 firms. ([3]) The α_1-α_3 parameters are those in equation (1), while the α'_1-α'_3 parameters capture their change according to the break years shown in the columns. ([4]) Chow test. When the break date is unknown, repeated Chow tests lead to the sup-Wald statistic, *i.e.* the largest F statistics (see Andrews, 1993) which in our case corresponds to the year 2002 in column (5). The corresponding test statistic is 2.11 against a 10 per cent critical value of about 4; then the estimates of the α_1, α_2 and α_3 parameters are jointly stable.

These interaction effects are associated with the α'_1 α'_2 α'_3 parameter estimates reported in Table 5. The results of the tests (Table 5, last three rows) seem to suggest the absence of any break: unobservable factors and shocks may explain the temporal evolution of the parameter estimates in repeated cross-sections. Given that the short time span available for testing suggests caution in interpreting this result, we cannot exclude the instability of one of the coefficients of equation (1). In particular, the α_2 parameter shows systematic signs of variability over time, confirming the cross-section evidence of Section 3.[14]

Figure 2

TIME VARYING ESTIMATES OF THE UNCERTAINTY PARAMETER



The thick solid line reports the estimates of α_{2t} parameters; the two thin. solid lines delimit the corresponding 95 per cent confidence interval. The dotted, horizontal line corresponds to the mean of the nine α_{2t} estimates (the shaded area delimit the 95 per cent confidence interval).

To investigate the issue further, we specified an equation where the α_2 parameter is allowed to vary over time in a deterministic way. More specifically, we substitute the α_2 parameter in equation (1) with nine interaction terms between uncertainty and time dummies (with α_{2t} parameters).

The time path of the α_{2t} estimates and of their standard errors is reported in Figure 2, together with their average $\hat{\bar{\alpha}}_2 = \frac{\sum_t \hat{\alpha}_{2t}}{9}$.

[14] Though in a different context and with more aggregate data, Caselli et al. (2003) find an instability of the demand effect on investment that disappears once uncertainty is included in the investment equation.

Although the differences between the α_{2t} point estimates appear to be not statistically significant,[15] their pattern in Figure 2 is suggestive of a shift occurring between the average estimates before and after the year 2000. In fact, the average estimate of the uncertainty effect in the 1996-2000 period is equal to –0.065 (standard error = 0.016), while it increases to –0.001 (standard error = 0.012) in the 2001-2004 period. Therefore, the estimated shift between the two periods is equal to 0.064 (standard error = 0.02) and is largely significant (t-statistic = 3.2).[16]

The explanation of such an evolution of the uncertainty effect requires a deeper analysis of the structural features of the uncertainty-investment relationship. In this paper we have investigated some of characteristics suggested by the literature, such as risk aversion, liquidity constraints, irreversibility, labour flexibility and the degree of market power.

Risk aversion is an unobservable variable that our panel approach, with individual and time effects, can properly account for in estimating the α parameters (while the cross-section approach can only do so to a very limited extent). However, it cannot be disentangled from other unobservable effects. For the other three determinants, some proxies are available and their correlation over time with the evolution of the uncertainty effect presented in Figure 2 can be analyzed. While for liquidity constraints we have shown their irrelevance in Section 4, for the other determinants a dynamic pattern cannot be excluded *a priori*.

In the case of reversibility, the technical progress may have had some effects on the characteristics of the capital goods, limiting their irreversibility once installed. Since suitable variables do not exist, we have employed some proxy based on the share of companies that have used second-hand and/or leasing markets for their capital goods. Had irreversibility decreased over time, according to our indicator the share of "reversible" firms should have increased. Actually, we observe the opposite effect: over the period under examination the share of reversible firms drops and this should imply a more negative effect of uncertainty.

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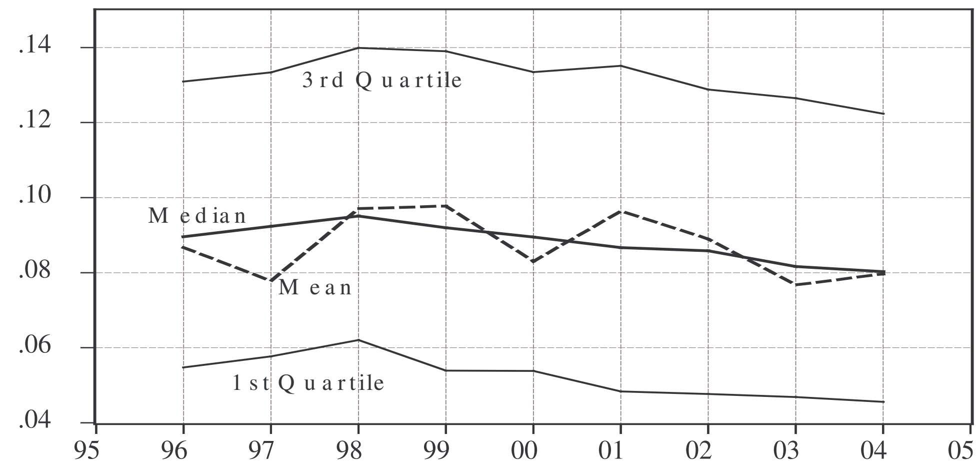
[15] The hypothesis that $\alpha_{2t} = \alpha_2 \ \forall t$ is not rejected (p-value = 0.38) and the two 95 per cent confidence intervals in Figure 2 (i.e. of α_{2t} and of $\hat{\bar{\alpha}}_2$) overlap; moreover, the average estimate $\hat{\bar{\alpha}}_2$ = -0.0307 is very close to the panel estimate, $\hat{\alpha}_2$ = -0.0318 (see Table 1).

[16] These results are robust to a number of alternative hypotheses about the behaviour of α_1 and α_3 parameters. In fact, the estimates in Table 5 might suggest a shift in the α_3 parameter as well. In order to prevent such shift affecting the α_{2t} estimates, we performed the same exercise as for Figure 2, but with a 2001 break in the α_3 parameter. Results for the α_{2t} estimates remain broadly unchanged. Finally, if we allow for a 2001 break in both the α_1 and α_3 parameters, the joint restriction to zero of the corresponding α'_1 and α'_3 parameters in a model with time varying α_{2t} is not rejected (p-value = 0.11).

For labour flexibility, the results in Section 5.2 show that their effect may be somehow obscured by that of the degree of market power, which shows, in Figure 3, a dynamic pattern consistent with that of the uncertainty effect. We have therefore chosen, at least initially, to concentrate only on the degree of market power.

Figure 3

PRICE-COST MARGINS OVER TIME [1]



(1) Measures of centre and dispersion of the price-cost margin sample distribution. Details about price-cost margin computation are given in Appendix A1.3.

In analogy with Domowitz et al. (1986), we address the influence of changes in price-cost margins on investment plans through demand uncertainty by adding an interaction with alternative measures of price-cost margins, X_{it}:

$$\frac{{}_tI_{it+1}}{K_{it}} = \alpha_i + \lambda_t + \alpha_1 \frac{{}_tY_{it+1}}{K_{it}} \left[1 + \left(\alpha_2 + \beta_2 X_{it}\right) \frac{u\left({}_tY_{it+1}\right)}{K_{it}} \right] \tag{3}$$

$$+ \alpha_3 \frac{I_{it}}{K_{it-1}} + \alpha_4' Z_{it} + \varepsilon_{it+1}$$

In this way the coefficient α_2 in equation (1) is allowed to vary over time as a linear function of market power: $\alpha_{2,it} = \alpha_2 + \beta_2 X_{it}$, where the β_2 parameter measures the influence of the market power proxy X_{it} on the effect of uncertainty on planned investments. Equation (1) is a valid reduction of (3) when the restriction $\beta_2 = 0$ holds; moreover, the validity of our conjecture that the evolution of the uncertainty effect is driven by the dynamics of the price-cost margin implies that in equation (3) $\beta_2 < 0$.

In Table 6 we report only the estimates of equation (3) based on the level of price-cost margins (PCM_{it}; in another set of regressions we have also used the deviation of PCM_{it} from its sectoral median/mean at time *t* and that from the overall sectoral median/mean with no significant change to the estimates). The β_2 estimate (column 1) is negative and very significant, thus supporting our assumption that the degree of market power affects investments through uncertainty, in line with the variability over time of the α_{2t} parameter.

Table 6

INCLUSION OF MARKET POWER PROXIES IN EQUATION (1) [1]

	(1)	(2) [2]	(3)	(4)
X_{it} =	PCM_{it}	PCM_{it}	PCM_{it} and OP_{st}	PCM_{it} and WT_{it}
Parameters: [3]				
α_1	0.0302	0.0305	0.0300	0.0305
	(0.0134)	(0.0137)	(0.0132)	(0.0136)
α_2	0.0050			
	(0.0124)			
α_3	0.0093	0.0091	0.0098	0.0087
	(0.0536)	(0.0537)	(0.0533)	(0.0535)
β_2	-0.3405	-0.3037	-0.5088	-0.4504
	(0.1493)	(0.1109)	(0.2059)	(0.1825)
γ_2			0.0175	0.0259
			(0.0138)	(0.0248)
RMSE	0.1790	0.1790	0.1787	0.1788
R^2	0.1351	0.1349	0.1382	0.1371

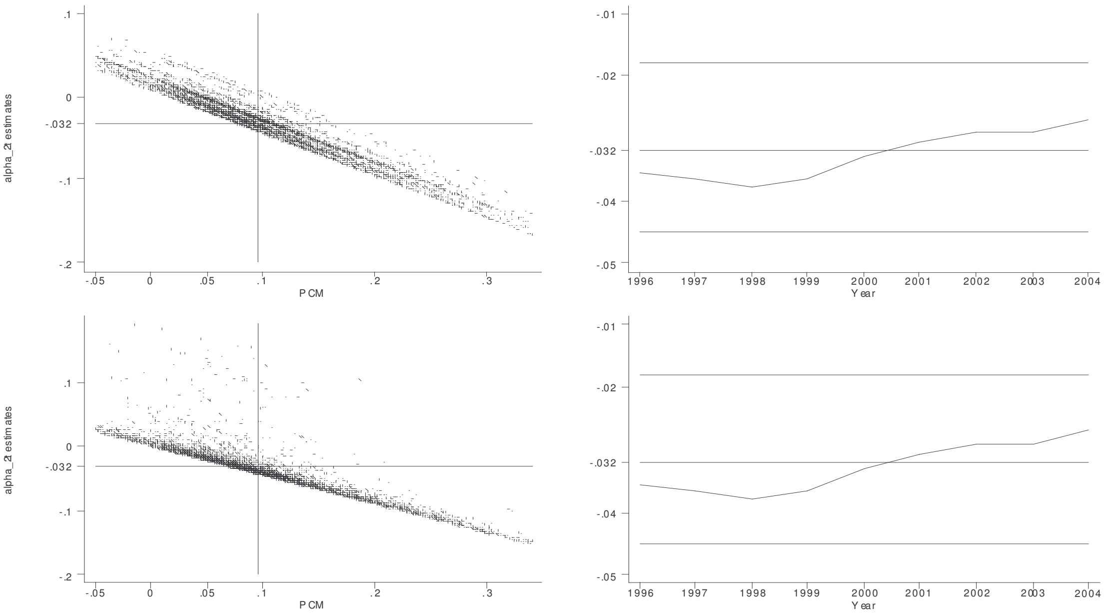
([1]) Robust standard errors in brackets. Sample dimensions: N×T=7104 and N=2080; 7 per cent of observations and of 2.8 per cent of firms are lost for the merging of the SIM and the CADS databases. ([2]) Obtained by imposing zero-restrictions to non-significant estimates in column (1) specification. ([3]) Parameter definitions in equation (3); γ_2 parameter has the same meaning as the β_2 parameter.

In the previous sections we have shown that the proxy of the degree of market power may be better measured by considering the effect of competition from foreign firms, both on internal and international markets, and the role played by the characteristics of the labour input. More specifically, we have taken into account two variables: an indicator of the foreign openness of the sector to which the individual company belongs (OP_{st}), defined as the sum of imports and exports over the value added at factor cost (see Appendix A1.3); a labour flexibility indicator, given by the turnover index (WT_{it}, see Section 5.2). In these two cases *X* becomes a vector of two variables and the new parameter to be estimated, say γ_2, measures the interaction between uncertainty and *OP* or *WT*, as β_2 in the case of *PCM*.

The estimates of these two extensions - see columns (3) and (4) of Table 6 - do not appear significant: for the WT indicator this may be interpreted as a confirmation of the previous finding about the dominance of the PCM (see Section 5.2); for the *OP* indicator it might be due to its reduced variability, as it is measured at the sector level. However, in both cases the estimates of the coefficient of PCM are highly significant.

Figure 4

THE RELATIONSHIP BETWEEN UNCERTAINTY EFFECTS PRICE-COST MARGINS, OPENNESS AND TURNOVER



The two left-hand panels show the relationship between the uncertainty effect and PCM (the horizontal line corresponds to the panel estimate, the vertical one to the sample PCM average). The right-hand panels show the corresponding time paths of the uncertainty effect measured by the average of the estimates (the three horizontal lines correspond to the panel estimate, equal to -0.032, and its 66 per cent confidence interval).

Figure 4 (left-hand panels) shows the two estimated relationships $\alpha_{2,it} = \beta_2 PCM_{it} + \gamma_2 WT_{st}$ and $\alpha_{2,it} = \beta_2 PCM_{it} + \gamma_2 OP_{st}$ for each individual company; when either *OP* (top-left panel) or *WT* (bottom-left panel) increases $\alpha_{2,it}$ moves to the top-right, implying a weakening of the uncertainty effect. These results are consistent with an explanation of the progressive weakening of the uncertainty effect based on the reduction of the price-to-cost margins along with an increase in labour turnover and in the competitive pressures from foreign companies.

7. The uncertainty-investment relationship: just a cyclical phenomenon?

The link between the uncertainty effect on investment plans and the price-cost margin could be interpreted in a strictly cyclical context. According to Domowitz et al.

(1986) the evolution of the price-cost margins appears to be pro-cyclical, driven by demand: during expansionary phases the price-cost margin is higher than in recessionary periods. In the light of our results, this implies that the uncertainty effect on investment should be counter-cyclical. As this effect is inversely proportional to price-cost margins, during an expansion the presence of uncertainty acts as a brake on the propensity to invest. Vice versa, in recessions the negative effect of uncertainty weakens considerably. This is an interesting result, which has never been analyzed before. But is it the whole story?

A stream of the theoretical literature on the investment-uncertainty relationship emphasizes the role of capital irreversibility along with some assumptions about the product markets and the technology of the firm. Another stream of the literature puts the emphasis also on the other production input, labour: when a firm operates in perfect competition and the labour input is flexible, the uncertainty effect may become non-negative. This implies that, besides cyclical factors, there might be a more structural explanation behind the evolution of the uncertainty effect.

Thanks to the availability of a panel of data on a fairly long time period, covering a complete business cycle, we show that the uncertainty effect on investment plans of a sample of Italian manufacturing firms evolves over time, gradually weakening. We are able to show that this time path may be influenced by the underlying evolution of the firm's price-to-cost margins, which have been decreasing smoothly over the period. If the price-cost margin may be considered a proxy of the degree of market power, our results could be interpreted as supporting the hypothesis that for companies with low market power the uncertainty effect is lower. More generally, this may imply that in a more competitive environment, the inherent volatility of investment may be lower because of the less significant role of uncertainty.

This seems to fit fairly well with the Italian manufacturing sector. Over the period under examination, international markets have been characterised by a rise in competition fostered by the fall in transport and communication costs, along with a reduction of trade barriers. New players have appeared, raising the competitive pressure on the production of the traditional industrial countries. The Italian manufacturing sector, traditionally specialized in low-technology products, has been particularly hit by these global trends. At the same time, Italian firms have experienced another profound change: the adoption of the euro, the European common currency, that ruled out the possibility of devaluing the lira to regain some competitive power (the so-called "competitive devaluations" so frequent in the past economic history of the Italian economy).[17]

Along with these external factors, the labour market in Italy has undergone a process of slow but constant change, with a series of economic policy decisions aimed at reducing the degree of rigidity in the use of the labour input. We have shown that for firms employing a more flexible labour input (in terms of both employees and working hours) uncertainty about expected demand has a weaker effect on investment decisions. This result casts a new light on the issue of labour flexibility implications. The recent literature (see Brandolini *et al*, 2006) has shown that a higher degree of flexibility may have negative effects on the firm's productivity as the reduction of hiring and firing costs make it more convenient to employ 'less efficient' workers. Our findings suggest that efficiency might also be improved via the positive relationship between the degree of labour flexibility and the elasticity of investment with respect to demand. In general, both at the international and at the domestic level, we can identify a common evolution towards an economic environment, in which the interplay of a higher degree of competition, a more flexible labour market and the production technology may imply a weaker effect of uncertainty on investment decisions.

This conclusion, and the whole set of results presented in this paper, should be considered tentative however. Further research is needed to investigate the relationship between investment, uncertainty and demand. Another issue we have only marginally tackled is that of the proper dependent variable to use. So far, nearly all the empirical works have been based on realised investment, but most of the theory has to do with desired or expected investment (our "investment plans"). Our efforts (see Butzen *et al*, 2003, for a similar application to Belgian manufacturing firms) have shown that much can be gained by exploiting self-reported data when no other reliable information is available.

[17] There were other periods in the past when the lira joined a sort of monetary system. However these episodes cannot be compared with the adoption of the euro. While in the past everyone knew that the lira could at any moment withdraw from the monetary system, with the euro this appears to be quite impossible. In this sense we may say that a sort of psychological factor is at work: the awareness that the euro is 'irreversible'.

Appendix A1: Data sources and definition of variables

A1.1 – Effective and planned investments

From the SIM source, both effective and planned investments at current prices are available, disaggregated in three types of goods: structures, machinery and equipment; vehicles; non-residential buildings. For the i^{th} company (i = 1, 2, …, N, N = 4860) at year t (t = 1, 2, ..., T, T = 9, from 1996 to 2004), we indicate with INV_{it}^{j} and ${}_{t}INV_{it+1}^{j}$ the level of effective investment realised in t, and of the investment planned in t for $t+1$, respectively; the superscript j (= m or f) indicates the type of good. In this paper we choose to analyse the behaviour of investment in structures, machinery, equipment and vehicles (j = m), compared with that of buildings (j = f).[18]

The corresponding data at constant (1995) prices are obtained in the following way.

INV_{it}^{j} are deflated using the corresponding NA sectoral investment prices PI_{st}^{j} for all the companies belonging to s^{th} industry: $I_{it}^{j} = \frac{INV_{it}^{j}}{PI_{st}^{j}}$.[19]

The investment price for $t+1$ as perceived in t and used to deflate ${}_{t}INV_{it+1}^{j}$ is defined as: ${}_{t}PI_{it+1}^{j} = (1 + {}_{t}\pi_{it+1}^{j})PI_{st}^{j}$, where ${}_{t}\pi_{it+1}^{j}$ is the expected inflation of the j-type investment price (estimated from the SIM source)[20], and PI_{st}^{j} are the sectoral NA data defined above. Therefore, we obtain constant-prices planned investment as ${}_{t}I_{it+1}^{j} = \frac{{}_{t}INV_{it+1}^{j}}{{}_{t}PI_{it+1}^{j}}$.

A1.2 – Stock of capital

The data on capital stocks, at constant prices, are constructed, for both j = m and f, according to the formula:

$$K_{it}^{j} = (1 - \delta_{it}^{j})K_{it-1}^{j} + I_{it}^{j} \qquad \text{(A1.1)}$$

where I and δ are the effective investment at constant prices and the depreciation rate. By type of good investments, I_{it}^{j}, are those obtained in previous Section A1.1. The time series of depreciation rates δ_{it}^{j} by type of good j is derived from the NA, assuming that $\delta_{it}^{j} = \delta_{st}^{j}$ for all companies belonging to s^{th} industry.

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[18] SIM database reports, for each year in the sample, both preliminary and final investment figures. Given that the paper focuses on the explanation of planned investments for $t+1$, we prefer to use preliminary data because they are the only investment figures available in t, i.e. at the time new investments are planned. From statistical analyses, it turns out that preliminary and final data coincide for the large majority of cases (85 per cent for m goods and 91for f goods).

[19] Manufacturing activity is disaggregated into 13 sectors.

[20] From SIM, only the total-investment expected inflation, ${}_{t}\pi_{it+1}$, is available. Data for ${}_{t}\pi_{it+1}^{j}$ are estimated by exploiting the sectoral NA inflation differential of j-type investment with respect to the total $m+f$, i.e.: ${}_{t}\pi_{it+1}^{j} = {}_{t}\pi_{it+1} + (\pi_{st+1}^{j} - \pi_{st+1})$, where $\pi_{st+1}^{j} = \frac{PI_{st+1}^{j} - PI_{st}^{j}}{PI_{st}^{j}}$ is the j-type investment price inflation rate, and the total investment price inflation is defined as $\pi_{st+1} = \frac{PI_{st+1} - PI_{st}}{PI_{st}}$.

In order to obtain the initial values of the capital stocks, we exploit the "accounting" initial values K_{i0}^{j} obtained from CADS nominal book values, deflated with the same sectoral investment deflators employed for INV_{it}^{j}.[21] In particular, we used CADS balance sheet item 44 (land and non-residential buildings) plus item 45 (other buildings) to proxy for *f* capital stock, and item 48 (structures and machinery) plus item 51 (industrial and commercial equipments) to proxy for *m* capital stock. The main advantage of this approach is that it exploits the information at the firm-level: stocks directly refer to each firm, provided that its balance sheet is available in CADS. However, unavoidable drawbacks are the loss of observations induced by merging SIM and CADS data (1308 firms in the *m* case; and 1444 in the *f* case), and the impact on the results of formula (A1.1) of the accounting rules (such as revaluations and devaluations).

A1.3 – Dummy and other control variables

In the model estimation phase, a number of additional variables can be used either to take into account a number of company-specific characteristics, or to split the whole sample into sub-samples of interest. The additional variables can be classified in dummy and other control variables.

We defined dummy variables for: industry; location; type of ownership; size; share of exported production; time; extraordinary operations; zeros in effective investment and expected sales; credit rationing; reversibility. Note that industry, location, type of ownership, size, share of exported production are time invariant (i.e. cannot be used in fixed-effects panel models); time dummies are invariant across individuals; extraordinary operations, zeros in explanatory variables, credit rationing, and reversibility dummies vary over time and across individuals.

Industry. The manufacturing activity is disaggregated into 13 branches; for each branch we define a dummy variable.

Location. There are four dummies: North-West, North-East, Centre and South-Islands.

Type of ownership. The ownership is classified by two dummies: public (equal to 1 if the ownership is public, zero if it is private); and *spa* (equal to 1 for limited companies, zero for other types of joint-stock companies).

Size. The number of employees measures the company size. This characteristic is time invariant because, at a first stage, we measured the per-firm average employment over time, L_i, then we classified each company in one of the following five classes: very small ($L_i < 50$), small ($50 \le L_i < 100$), medium ($100 \le L_i < 200$), large ($200 \le L_i < 500$), very large($L_i \ge 500$).

Share of exported production. As for size, the average share of exported production by firm over time, X_i, classifies companies in the following five categories: no exporters ($X_i = 0$), moderate exporters ($0 < X_i \le 25$ per cent), medium exporters (25 per cent $< X_i \le 50$ per cent), large exporters (50 per cent $< X_i \le 75$ per cent), prevalently exporters ($X_i > 75$ per cent).

[21] In doing so, we did not adjust book values to take into account changes in the value of capital goods purchased in the past. For alternative approaches, see the data appendices in Chirinko and Schaller (2004) and in Chatelain and Teurlai (2001).

Time. Time dummies classify observations along time: $\lambda_t = 1$ if the observation refers to time *t*, zero otherwise. Therefore, λ_t dummies can be estimated in panel models but not in cross-sections, and their presence allows for a degree of dependency across companies in the panel due to collectively significant effects.

Extraordinary operations. Three dummy variables equal to 1 if the company has been subject in *t* to: de-merger, business combination, and merger.

Zeros in the model's explanatory variables. Two dummy variables, equal to 1 when expected demand and effective lagged investment are respectively zero. Note that zeros in the min-max range of growth in expected demand are not marked with a dummy (as we did for demand and investment), because we interpret such result as "absence of uncertainty".

Credit rationing indicator. It is equal to 1 if the firm is credit-constrained. It is constructed using the answers to three questions on access to credit provided by the firms in the SIM sample. Specifically, firms are asked whether (i) at the current market interest rate they wish a larger amount of credit; (ii) they would be willing accept a small increase in the interest rate charged in order to obtain more credit; (iii) they have applied for credit but have been turned down. A company is classified as credit-constrained if, given a positive answer to either question (i) or (ii), it also answered "yes" to question (iii).

Reversibility indicator. The reversibility of the installed capital goods may be represented by an indicator based on transactions in the secondary market and on leased investment (*reverst*). It is a dummy variable equal to one if in *t* the i^{th} firm purchased or sold investment goods in the second-hand market or leased them, zero otherwise. Leased investment is considered reversible because normally, as part of the leasing contract, the client acquires the option to return the good. As a consequence, leasing companies only finance the purchase of goods that enjoy large second-hand markets. Given that the question about leased investment has been dropped since the 2003 survey, *reverst* data are partially unavailable for 2003 and 2004. In order to avoid a loss of information, we constructed a second reversibility indicator (*REV*) at company level by collapsing annual *reverst* data by firm. *REV* is equal to one if collapsed *reverst* is bigger than 1, i.e. if the firm operated for at least two years either on the second-hand or the leasing markets during the sample period. Alternatively, we imputed missing *reverst* data on the basis of a probit model whose regressors are main dummy variables listed above (i.e. the same used in year-by-year regressions, see Section 3).

Cash flow, net of dividends paid. It is a no-dummy control variable. Individual data at current prices are from CADS database: CD_{it} = cash flow (item 9.14) minus dividends (item 7.6). In order to obtain data at constant prices, CD_{it} has been deflated using PY_{st} (the by-industry production deflator from NA, see e.g. Bond and Meghir, 1994): $CF_{it} = \frac{CD_{it}}{PY_{st}}$. In analogy with explanatory effective investment in *t-1*, in our model the cash flow regressor has been scaled by lagged stock of capital.

Price-cost margin. According to Domowitz et al (1986) and Guiso and Parigi (1996 and 1999), the price-cost margin *PCM*, by firm and year (i.e. the firm's profit margin on unit price) is defined as:

$$PCM = \frac{Sales + \Delta inventories - Payroll - Materials}{Sales} \qquad \text{(A1.2)}$$

where CADS is the source of all variables in the formula above. In particular, *Sales* is the total value of sales in nominal terms (item 6.1); *Δinventories* is the change in stocks (items 6.2+6.7); *Payroll* is labour costs (item 6.10); *Materials* is the cost of intermediate inputs (items 6.6+6.8). We then classify the i^{th} firm as having more or less market power in time *t* depending on whether their PCM_{it} is above or below either the median value of the firm's industry in time *t* or the median value of the firm's industry (see also Section 5).

Openness indicator. The intensity of competition from foreign companies is measured by the openness indicator OP_{it} defined as: $OP_{st} = \frac{M_{st} + X_{st}}{2 \times V_{st}}$, where M_{st} and X_{st} are respectively the value of the sectoral flows of import and export ISTAT foreign trade statistics, and V_{st} is the NA's value added at factor costs. The indicator has been computed by using in the denominator the value added at base prices and the value of production (both at factor cost and at base prices) with no significant change in the estimates.

Labour turnover indicator and labour flexibility in working hours. The two indicators are available at company-year level from the SIM dataset. The labour turnover is defined as: $WT_{it} = \frac{I_{it} + F_{it}}{W_{it}}$ where I_{it} and F_{it} are respectively the average number of incumbent and of fired/retired workers by company, and W_{it} is the average number of workers effectively employed during *t*. The labour flexibility in working hours is defined as: $WH_{it} = \frac{OH_{it} + CIG_{it}}{TH_{it}}$ where OH_{it} and CIG_{it} are respectively the total number of overtime and of CIG hours by company, and TH_{it} is the total number of hours effectively worked in that company during *t*. OH_{it} has been collected only since 1998, so that the indicator is available over the 1998-2004 period.

A1.4 – Sample representativeness

Table A1.1

PERCENTAGE COMPOSITION OF FIRMS BY SIZE, INDUSTRY AND LOCATION

	Population [1]		Our sample [2]
	>20	>50	
Manufacturing sectors:			
Textiles, clothing, leather, footwear	19.07	16.91	17.44
Chemicals, rubber and plastics	9.40	11.90	11.27
Metals, mech./elect. eng., motors, vehicles	43.74	45.24	47.87
Food, timber, furniture, paper and other	27.79	25.95	23.42
Total	*100.00*	*100.00*	*100.00*
Geographical location:			
North-West	37.65	42.72	42.44
North-East	31.69	31.53	15.87
Centre	16.78	14.80	24.95
South and Islands	13.88	10.95	16.74
Total	*100.00*	*100.00*	*100.00*

([1]) Italian firms with a size of more than 20 and more than 50 employees in 2002 (source ISTAT, 2005). ([2]) 7,642 firm-year observations of our basic sample.

Appendix A2: Matching investment plans and realisations

In the main text, specification (1) is based on expectations, for $t+1$, about investments, demand and demand growth, formed on the basis of the information set available in t. Obviously, if all plans were fully carried out, the use, as the dependent variable, of investment realisations in $t+1$ (*i.e.* $\frac{I_{it+1}}{K_{it}}$) rather than planned investments (*i.e.* $\frac{{}_tI_{it+1}}{K_{it}}$) would lead to the same estimation results outlined in previous sections.

To what extent planned and actual investments differ can be assessed on empirical grounds. Thanks to the informative content and to the time dimension of the SIM (see Appendix A1.1), we are able to match investment plans made in t with the corresponding realisations in $t+1$ for all those companies belonging to both t and $t+1$ sample datasets. Note that matching implies losing observations because of both attrition and missing realisations for the year 2005. Therefore, we can measure the discrepancy between nominal investments planned for $t+1$ (${}_tINV_{it+1}$) and effective investments in $t+1$ (INV_{it+1}), in order to summarise its statistical relevance. We will call this indicator rate of investment plans realisation, $RIPR_{it+1} = 100 \times \frac{INV_{it+1} - {}_tINV_{it+1}}{{}_tINV_{it+1}}$. We arbitrarily assume that a company's plan are almost-fully carried out if its actual investment in $t+1$ is within 5 percent above or below the plan it made in t, i.e. if $|RIPR_{it+1}| < 5\%$.

In the SIM 11,044 matching observations, only 9.6 per cent of cases fulfils the $|RIPR_{it+1}| < 5\%$ condition. This share is slightly lower than the one (9.8 per cent) obtained by focusing on the 5,770 observations belonging to the estimation sample of equation (1) and by using real (instead of nominal) investment data to compute: $RIPR_{it+1} = 100 \times \frac{I_{it+1} - {}_tI_{it+1}}{{}_tI_{it+1}}$. With real investment data, $RIPR_{it+1}$ slightly improves, although the shift from matching nominal investments (SIM case) to matching real investments (equation (1) estimation sample) introduces an additional source of noise due to investment price forecasting.

If we concentrate on firms' ability to forecast their future demand by comparing expected demand in t for $t+1$ and actual demand in $t+1$, the share of companies with discrepancy, in absolute value, lower than 5 increases to 34.2 per cent in the SIM (nominal demand) case, and to 36.5 per cent in the equation (1) estimation sample (real demand). This fact suggests that future demand is much easier to predict than investment activity.

From a descriptive point of view, a 10 per cent share of cases in which investment plans are almost met seems a very poor proportion, based on an arbitrary 5 per cent range assumption about $RIPR_{it+1}$. Therefore, the empirical relevance of using either planned or actual investments to explore the investment-uncertainty relationship can be assessed by using estimation methods: if actual and planned investments substantially differ because of the accrual of new information from t to $t+1$, the choice of the investment measure on the left-hand-side of our model will lead to different inferences (and perhaps conclusions).

Table A2.1 reports the estimates from a number of econometric exercises, where the dependent variable, $\frac{{}_tI_{it+1}}{K_{it}}$, of equation (1) is replaced by its actual realisations, $\frac{I_{it+1}}{K_{it}}$. Given that $\frac{I_{it}}{K_{it-1}}$ is listed among the explanatory variables, the model on which we base the inferences of Table A2.1 is a classical dynamic panel model. In such circumstances the conditions of absence of correlation between regressors and the error term are no longer valid, and a GMM approach is necessary to obtain consistent and efficient parameter estimates.

Table A2.1

ESTIMATION BY MATCHING ACTUAL AND PREDICTED DATA [1]

	(1)	(2)	(3)	(4)	(5)
dependent variable:	$\frac{I_{it+1}}{K_{it}}$	$\frac{I_{it+1}}{K_{it}}$	$\frac{I_{it+1}}{K_{it}}$	$\frac{I_{it+1}}{K_{it}}$	$\frac{I_{it+1}-{}_tI_{it+1}}{K_{it}}$
Regressor:					
$\frac{{}_tY_{it+1}}{K_{it}}$	0.0077 (0.0046)	0.0033 (0.0024)			0.0013 (0.0022)
$\frac{Y_{it+1}}{K_{it}}$			0.0092 (0.0054)	0.0051 (0.0035)	
$\frac{u({}_tY_{it+1})}{K_{it}}$	-0.0388 (0.0422)	-0.0144 (0.0850)	-0.0091 (0.0483)	0.0071 (0.0729)	0.0918 (0.3615)
$\frac{I_{it}}{K_{it-1}}$	0.0727 (0.0276)	0.0007 (0.0256)	0.0783 (0.0278)	0.0114 (0.0251)	0.0133 (0.0129)
$\frac{{}_tI_{it+1}}{K_{it}}$		0.4220 (0.0462)		0.4172 (0.0500)	-0.4598 (0.1509)
$\frac{Y_{it+1}-{}_tY_{it+1}}{K_{it}}$					-0.0001 (0.0064)
Over-identifying restrictions [2]*:*					
J test statistics	65.44	78.78	61.08	66.55	61.07
degr. of freedom	57	76	52	71	55
P-values	20.71%	39.10%	18.21%	62.74%	26.70%
Autocorrelation tests (p-values) [3]*:*					
1st order	1.36%	3.93%	1.20%	3.67%	4.04%
2nd order	23.52%	55.61%	28.76%	56.57%	46.97%
$\alpha_1 = \alpha_2 = \alpha_3 = 0$ [4]	0.05%	16.72%	0.01%	9.76%	16.82%
Models' fitting [5]	0.0711	0.3400	0.0755	0.3395	0.3486

(1) Blundell and Bond (1998) GMM-sys estimates, with robust standard errors (in brackets), from an unbalanced panel of 5,770 observations for 1,761 companies; average $T_i = 3.28$. (2) Hansen (1982) over-identifying restrictions (*df*) test, $\chi^2(df)$. (3) Arellano and Bond (1991) autocorrelation of residual of order *p*, $\chi^2(p)$. (4) P-values of the Wald statistic testing the joint significance of demand, of uncertainty and of lagged effective investment parameters, $\chi^2(3)$. (5) Measured as the squared sample correlation between the actual and fitted values.

In Table A2.1 we present results from the GMM-sys estimates (see Blundell and Bond, 1998); as instruments, we use lags *t-2* and *t-3* of the explanatory variables. The robustness of our findings is confirmed when Arellano and Bond's (1991) GMM-dif estimator is applied (results are not reported but are available upon request). In the lower part of the table it is shown that the estimation results pass the specification tests (overidentifying restrictions and second-order residual autocorrelation).

Column (1) in Table A2.1 reports the estimates of our basic specification (1) in which actual investment is used as the dependent variable. Results, if compared with those reported in the first column of Table 1, suggest: a relevant loss of magnitude in the effect of expected demand on actual investment, 10 per cent (but not 5) significantly different from zero; a no longer statistically significant effect of uncertainty; and a strong significance of the autoregressive parameter, reflecting the presence of dynamics in the actual investment pattern. The relevance of the α_3 parameter, together with a weak evidence of expected-demand effects on actual investment (α_1), explain the strong rejection of the joint constraint $\alpha_1 = \alpha_2 = \alpha_3 = 0$ (p-values are reported in the corresponding line of Table A2.1).

Although these results point to the irrelevance of demand uncertainty in explaining actual investments, one should expect that firms with higher perceived uncertainty in *t*, and thus with lower investment planned in *t* for *t+1*, will end up with lower actual investment in *t+1*. In order to validate this hypothesis, column (2) reports the estimation results from a model in which investments planned in *t* for *t+1*, $\frac{{}_tI_{it+1}}{K_{it}}$, are added to the list of explanatory variables of the model estimated in column (1). Results suggest that, despite the very low share of cases in which plans are met (see above), investment plans are the main driving force of actual investment: almost half of the investment plans made in *t* are embodied in *t+1* actual investments; the joint significance of the other explanatory variables - including dynamics - vanishes (the constraint $\alpha_1 = \alpha_2 = \alpha_3 = 0$ is not rejected with a p-value of 16.7 per cent).

The findings from columns (1) and (2) are confirmed by substituting, in the list of the explanatory variables, the demand expected in *t* for *t+1* with the actual demand in *t+1* (see columns (3) and (4)). It becomes even more evident that uncertainty is irrelevant, and that actual demand has a smaller effect because it is partly embodied in the planned investments when they are added to the model specification in column (4).

The inclusion of investment plans (in columns 2 and 4) considerably raises the explanatory power of models for effective investments, as evidenced by the squared coefficient of correlation between actual and fitted values (in the bottom line of Table A2.1). This result raises the question about the rationality of the investment plans: if the plans embody all the information available in *t* on expected future demand and its uncertainty, differences between actual and planned investments should be dictated only by news. In order to explore this point quantitatively, we estimate the following model, which accounts for a number of sources of forecast error, defined as the difference between plans and realisations:

$$\frac{I_{it+1} - {}_tI_{it+1}}{K_{it}} = \alpha_i + \lambda_t + \beta_1 \frac{{}_tY_{it+1}}{K_{it}} \left[1 + \beta_2 \frac{u\left({}_tY_{it+1}\right)}{K_{it}} \right] + \beta_3 \frac{I_{it}}{K_{it-1}} + \\ + \beta_4 \frac{{}_tI_{it+1}}{K_{it}} + \beta_5 \frac{Y_{it+1} - {}_tY_{it+1}}{K_{it}} + \\ + \alpha_4' Z_{it} + \nu_{it+1} \qquad \text{(A2.1)}$$

The explanatory variables in the first line of equation (A2.1) exactly represent the same information set available at time *t* and embodied by equation (1). In principle, this information might be further exploited to reduce the forecast error; if not, the investment plans are rational and the restrictions $\beta_1 = \beta_2 = \beta_3 = 0$ hold.

The explanatory variables in the second line of equation (A2.1) respectively measure the effect of: investment plans made in *t* for *t+1* (β_4 parameter); the one-step-ahead prediction errors of demand (β_5 parameter). If plans are an unbiased predictor of actual investments, it must be $\beta_4 = 0$. The constraint $\beta_5 = 0$ implies that the demand forecast errors are not a significant explanation of the discrepancy between planned and realised investments. The error term v_{it+1} represents the (unpredictable) news occurring from *t* to *t+1*. Finally, the vector Z_{it} includes the same additional control variables as equation (1).

Estimation results are reported in column (5) of Table A2.1. The parameter estimates for the effects of expected demand, uncertainty and lagged actual investments are not significant, either individually or jointly (the p-value of the hypothesis that $\beta_1 = \beta_2 = \beta_3 = 0$ is equal to 16.8%). As for previous results, investment plans appear to be rational with respect to all the relevant information available in *t* (the same result is obtained in a model that excludes both investment plans and errors in forecasting demand, see Guiso and Parigi, 1999).

As far as the effect of errors made in forecasting demand one-step-ahead is concerned, the estimate of the β_5 parameter is very close to zero and not significant. This result supports what has previously been noted: given that the discrepancy between actual and predicted demand is considerably smaller than for investments, such forecast errors do not affect the discrepancy between investment plans and realisations. Finally, only the β_4 parameter estimate is significantly negative, suggesting that the forecast error of investments is negatively driven by the amplitude of the plan: the bigger the plan, the higher the (negative) discrepancy between actual and planned investments.

Overall, the results of this section lead to the following two main findings.

Firstly, the evidence reported in Table A2.1 can explain the controversial sign and the low significance of the effect of uncertainty on investments, as reported by the empirical literature solely based on actual and accounting data.

Secondly, investments planned in *t* for *t+1* are able to explain actual investments in *t+1* much better than the effective demand in *t+1*. This is despite the fact that they do not convey any news occurring from *t* to *t+1*.

Together, these results make it evident that data from survey questionnaires provide an invaluable source of information for better explaining companies' behaviour and for predicting their investment patterns. In fact, the availability of plans, expectations, and perceptions obtained directly from firms avoids the use of proxies based on very restrictive models and/or assumptions that may be misleading.

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