Economics Bulletin

Volume 32, Issue 4

Individual risk attitude, product innovation and firm performance. Evidence from survey data.

Marco Cucculelli
Università Politecnica delle Marche

Abstract

We use survey data on individual risk attitude and discount rates to test the impact of individual risk profile on the firm innovation activity and firm performance. Empirical evidence from 163 Italian entrepreneurs shows that risk-loving individuals and individuals with smaller than average discount rates introduce products that affect firm growth rates significantly.

Citation: Marco Cucculelli, (2012) "Individual risk attitude, product innovation and firm performance. Evidence from survey data.", *Economics Bulletin*, Vol. 32 No. 4 pp. 3197-3212.
Contact: Marco Cucculelli - m.cucculelli@univpm.it.
Submitted: August 04, 2012. **Published:** November 19, 2012.

1. Introduction

Since long the literature on entrepreneurship has acknowledged that the rewards of entrepreneurial activity are highly variable and largely uncertainty-driven. As a consequence, the selection of individuals into entrepreneurial activity by risk attitude levels has induced relevant theoretical analysis and got a substantial empirical support.

Risk plays a central role also in entrepreneurial decision following the individual selection into the entrepreneurial activity. A large literature (both in economics and managerial studies) addresses the issue of how the individual risk characteristics shape the behaviour of the entrepreneur; in particular, how risk attitude affects the decision making process in a company. However, despite the relevance of the topic, a clear hypothesis linking elicited risk preference to firm strategic decisions has not been put to an empirical test. This is probably due to a lack of sample surveys from which a direct individual measure of risk attitude can be obtained and used in subsequent empirical analysis of firm behaviour.

Following Forlani and Mullins (2000), we can conceive a risky decision like the one where the decision to adopt a new product is driven by the variability in its anticipated returns. The greater will be the variability in predicted outcomes and the hazard of losses - which also entail higher potential gains, the greater will be the perceived risk of a project. It can be assumed that decision makers with lower risk aversion and lower than average discount rates will be more likely to pursue riskier decisions, whereas less risk-tolerant individuals will take decision with more secure and stable returns. Similarly, for new products of equal variability and expected value, risk attitude is expected to influence choices which differ in amount of hazard and gain, such that less risk averse decision makers will opt for new product introduction with higher levels of hazard (Forlani and Mullins, 2000). Consequently, a negative correlation between the firm growth rate and the entrepreneur risk attitude may be expected as a result of the selection process of new products induced by the risk profile of the decision makers.

Some recent contributions offer evidence to this claim (Soderbom and Pattilo, 2000; Sauner-Leroy, 2004; Rauch et al, 2004;) but controversial results can also be found (Nardi et al, 2007; Avlonitis and Salavou, 2007). Because of this mixed results, the relation between risk attitude and firm performance is still an open area of research.

The aim of this paper is to contribute to this literature by studying the impact of risk attitude (risk aversion and time discount rate; Andersen et al, 2008) on the decision process regarding the product adoption within a firm. We elicit individual risk preference and individual discount rates from a purposely constructed survey on 163 decision-makers (entrepreneurs) in a sample of Italian medium size manufacturing firms. We relate this survey information to the innovative behaviour the firm, as summarized by the decision to introduce a new product, in a model of endogenous product portfolio selection and firm growth.

Our measures of risk attitude are drawn from the existing empirical literature (Cramer et al., 2002; Thaler, 1981). We elicited individual risk preferences from a survey questionnaire in which individuals had to respond as to how much they would pay for a ticket in a lottery with 10 tickets and a single prize (Cramer et al. 2002). In order to take into account the positive correlation between the individual wealth status (the investment size of the company for the entrepreneur) and his risk attitude, we adjusted the lottery prize by asking each entrepreneur the maximum investment that the firm would be able to sustain (the amount at risk) and we used this information to calibrate the prize of the lottery. As far as discount rates were involved, we used the framework put forward by Thaler (1981) to estimate how individual discount rates vary according to the size of the reward (prize) and the length of the waiting period for the lottery prize to be received.

Our empirical results show that differences in both the risk attitude and the discount rates influence firm growth through the selection of products that enter the firm's portfolio. Risk-loving individuals and those who discount future events less heavily seem to be able to select products with larger potential impact on the revenues of the firms. Conversely, risk-averse individuals and individuals with larger than average discount rates appear to select products that affect firm growth less intensely.

The paper is organized as follows. Section 2 briefly summarizes the relevant literature on the topic. Section 3 reports some descriptive statistics on the survey variables used in the empirical application. Section 4 describes econometric specification of corporate growth model adopted in the empirical analysis and data. Section 5 presents results and Section 6 concludes.

2. Risk attitude, product choice, and a firm's performance

Innovative activity carries an element of high uncertainty, and although it may increase the probability of superior performance, it cannot guarantee it. An innovation strategy – such as the introduction of a new product – is, therefore, even more uncertain than playing a lottery because, neither the probability of winning, nor the prize can be known for sure in advance (Coad and Rao, 2008). Another feature of the innovation process is that there is uncertainty at every stage, and that the overall outcome requires success at each step of the process. In a pioneering empirical study, Mansfield identified three different stages of innovation that correspond to three different conditional probabilities of success: the probability that a project's technical goals will be met (x); the probability that, given technical success, the resulting product or process will be commercialized (y); and finally the probability that, given commercialization, the project yields a satisfactory return on investment (z). The overall success of the innovative activities will be the product of these three conditional probabilities ($x \times y \times z$). If a firm fails at any of these stages, it will have incurred costs without reaping benefits. We therefore expect that decision-makers with different risk attitudes differ greatly both in terms of the returns to post-innovation sales growth and also in terms of the time required to convert an innovation into commercial success.

Assuming that a successful innovation is one which translates into a profitable business, we have to admit that some entrepreneurial companies are able to discover and exploit available opportunities, whereas, others cannot or will not (Cruz and Nordqvist, 2010). Decision makers often have to rely on a subjective assessment of the commercial viability of their new product innovation. This assessment can be influenced by the degree of risk aversion of the firm's decision maker.

It is conventional wisdom that a high level of risk aversion discourages individuals from entrepreneurship as opposed to wage employment (Gifford, 2003; Kihlstrom and Laffont, 1979; Binswanger, 1981;)[a]. However, literature has also stated that entrepreneurs are not homogenous with regard to their risk-taking attitude, thus making the previous distinction between entrepreneur and manager less significant. Reynolds *et al*. (2002) introduced the notion of necessity entrepreneurship, as opposed to opportunity-based entrepreneurship. Wagner (2005) reports some evidence for a higher risk aversion by necessity entrepreneurs relative to opportunity entrepreneurs. Similarly, Block *et al*. (2009) demonstrated that entrepreneurs who seek to take advantage of a new business opportunity are more willing to take risks than (necessity) entrepreneurs who declared that they have no better alternatives

[a] Palich and Bagby (1995), Keh et al. (2002), and Elston and Audretsch (2010) found evidence of a weak impact of risk attitude in the entrepreneurial decision to start a company.

than employment. In addition, when motivated by being creative or independent, entrepreneurs appear to be less risk-averse as compared with other entrepreneurs.

According to the agency theory, the perception of risk and consequent behavior adopted by the firm can vary when ownership and management are separated, with managers characterized by higher risk aversion (Weber *et al*., 2002; Van Praag and Booij, 2003). This view is not unambiguously supported by empirical research, because several studies have found no significant difference between risk-taking behaviors of the two categories (Busenitz and Barney, 1997). Other studies have moved beyond the risk-assessment impact of a single economic agent to focus on the whole organization's risk behavior. From this standpoint, some differences have been found among the risk attitudes of family and nonfamily run firms as far as second-generation family managers are concerned (Naldi *et al*., 2007).

This article will not go through the topic of assessing the risk behavior of different typologies of entrepreneurs. From previous literature, we derive the idea that we should observe firms whose decision-makers are endowed with different degrees of risk aversion (Andersen *et al*., 2008). This may influence the choice of risky decisions taken within a firm, hence the overall performance of the firm (Norton and Moore, 2006), regardless of the functional position of the decision-maker in the company (entrepreneur, lone founder, external CEO, family manager or CEO etc). Specifically, in our context of new product introduction, risk derives from the uncertainty which involves the whole process ranging from the initial stage of translating ideas into real goods, to the final step of their commercialization in the market (Crawford and Di Benedetto, 2006; Tyagi, 2006; Mu *et al*., 2009).

Following Forlani and Mullins (2000) and Sauner-Leroy (2004), we can understand the decision of a risky choice (such as the one where, among various alternatives, a new product is actually adopted), as driven by the variability in the anticipated returns of the different new products under examination, and any potential operating losses which may ensue. The greater the variability in predicted outcomes (Fisher and Hall, 1969) and the hazard of losses which also entail higher potential gains (March and Shapira, 1987), the greater will be the perceived risk of a project. It can be assumed that decision makers with lower risk aversion will be more likely to pursue decisions involving a riskier choice. Less tolerant risk individuals will take decisions that are more secure and yield stable returns. Finally, for new products of equal variability and expected value, risk attitude is expected to influence choices which differ in the quantum of hazard and gain, such that less risk-averse decision makers will opt for new product introduction regardless of higher levels of hazard (Forlani and Mullins, 2000).

Also, the literature on the real option approach to a firm's investment provides further insight concerning the motivations underlying the product selection process and its introduction (Dixit and Pindyck, 2000). According to this view, product adoption can be evaluated as a call option whose value increases with riskiness of the underlying asset, that is, the stream of revenue coming from the investment (or the product, in our case). This finding, which holds under risk neutrality, makes for a strong and individual utility-based valuation of the investment completely equivalent. However, although large shareholders may be able to perfectly diversify their wealth, corporate executives and owner-managers in small businesses, or in family run businesses, are typically exposed to idiosyncratic risk. As a result, their policy choices should reflect their attitude toward risk. Hugonnier and Morellec (2007) show that managerial risk aversion, typically, has a large impact on investment policy and project value, and the difference in net present values under firm and utility-maximizing policies can differ substantially. More generally, when agents with differences in their preferences are introduced in this framework, risk aversion can affect the investment policy substantially (Gifford, 2003; Wachter, 2003). As for the investment policy, risk attitude can also affect the entrepreneurial choice in selecting and introducing a new product and, ultimately, have an impact on the firm's growth.

Finally, as a general principle, it holds that expected returns and risk are positively related – the higher the risk, the higher the expected rate of returns on an investment, and conversely, the lower the risk, the lower the expected rate of returns. Consequently, we expect risk-loving decision makers to achieve better firm performance. Some recent contributions in the entrepreneurship and finance literature offer evidence to this claim (Soderbom and Pattilo, 2000; Rauch *et al*., 2004), but controversial results can also be found (Zahra, 2005; Avlonitis and Salavou, 2007; Naldi *et al.*, 2007). Because of these mixed results, the relation between risk attitude, product selection, and firm performance is still an open area of research which we aim at contributing to on an empirical ground.

3. Data and variables measurement

3.1. Sample

The dataset employed refers to 163 Italian small and medium manufacturing firms and it has been built by matching two complementary sources: i) a cross-sectional survey dataset, collected by Fondazione A.Merloni[a] directly from the companies using questionnaire-based phone interviews, and ii) an accounting dataset that consists of company accounts of interviewed firms from 2000 to 2008 (AIDA Bureau van Dijk).[b] Table A1 in the Appendix provides descriptive statistics of the variables used in the empirical model.

The dataset contains disaggregated survey information at the firm level, such as the year of the product introduction and the risk profile of the entrepreneur (risk attitude and individual discount rate; see below).

We interviewed the "person in charge of major decisions" within the company and we refer to that person as the entrepreneur. Therefore, respondents can be founders, heirs or managers, all having in common the decision making authority within the company.

The type of new product introduction that we have considered involves a radical change in the product portfolio of the company and a substantial enhancement of the firm capabilities (technical and commercial) for the realization of the product. We followed the suggestion put forward by Bernard et al. (2006) by considering a new product - a different five-digit NACE category in the firm product portfolio; we do not consider small refinements or negligible enhancements in the existing features of the product.

Data on product introduction has been obtained by asking the interviewed persons the following questions. "After having listed all the products present in product portfolio, please give separately for each product: (i) a detailed description of the product characteristics and a comparison with other products in portfolio; (ii) the year of introduction of the product." By using the detailed product description from question i), we coded manually each product in a five-digit classification in order to define the whole firm product portfolio. Besides, question ii) allows to specify the panel structure of the innovation variable INNO, that is the distribution over time of the new product introduction events.

---

[a] The Fondazione A.Merloni is a no-profit Italian institute for economic and social research.

[b] The AIDA Bureau van Dijk database is an authoritative and reliable source of information on Italian companies. Information is drawn from official data recorded at the Italian Registry of Companies and from financial statements filed at the Italian Chambers of Commerce. Companies furnish data on a compulsory basis. The information provided includes company profiles and summary financial statements (balance sheet, profit and loss accounts, and ratios). Each company's financial statement is updated annually. Additional information on the AIDA Bureau van Dijk database can be retrieved on http://www.bvdinfo.com

3.2 Risk attitude

Data on risk attitude has been obtained by asking decision-makers the following two questions:

Q1. What is the largest amount the firm can invest? Answer: X

Q2. How much would you pay a ticket in a hypothetical lottery with 10 tickets and a single prize of the same amount of the investment you have specified in the previous question, i.e. X?

Except for the adjustment of the amount of prize, the question we used to elicit individual attitudes is the same as in Cramer et al. (2002). Despite it having the same drawback due to its *ex post* character already signalled by the authors, it has also the same element of originality in that it uses a direct measure of risk aversion rather than an *ex post* revealed attitude. The reservation price is the price respondents would pay for the ticket (Harrison et al. 2007). The simplest way to use the reservation price as a measure of risk aversion is a transformation of the reservation price (Cramer et al. 2002):

$$\text{TPB} = 1 - \frac{P_1}{X/10}$$

where P_1 is the reservation price and $X/10$ is the fair value of the lottery. As in Cramer et al. (2002), we have used TPB as a measure of individual risk attitude in the econometric analysis. Table 1 reports differences in the average growth rates for the sub-samples of risk-averse and lovers (using the median TBP value). About 77% of interviewed “decision makers” are risk-adverse, 17% are risk-neutral and 7% are risk-lovers. These results are very close to those by Cramer et al. (2001), who report 80%, 17% and 3% respectively for risk-averse, risk-neutral and risk-lovers in their sub-sample of entrepreneurs. According to results of Student’s t-test on the difference of the means, the growth of innovative firms is statistically higher than the remaining firms.

Table 1 - Test on the difference between average sales growth rate of firms according to new product development activity and risk attitude

Sub-sample of firms	Mean sales growth rate (logarithmic difference among annual sales)	Obs.	Student t-test on the difference of the mean [P (T < t)]
Innovation between 2000 and 2006	0.114	150	–2.8444
No Innovation between 2000 and 2006	0.066	828	[0.0022***]
Risk adverse	0.064	774	-
Risk neutral	0.198	132	-
Risk lovers	0.144	72	-
High discount rate (>mean score)	0.084	468	–2.844
Low discount rate (< mean score)	0.041	510	[0.0084***]
Total	0.059	978	-

Source: Fondazione A.Merloni Survey and AIDA Bureau van Dijk

3.3 Individual discount rates

Following Cramer et al. (2002), Weber et al. (2002), van Praag and Booij (2003), Harrison et al. (2010) it is questionable whether these measures of risk aversion are constant and permanent. We therefore evaluate how discount rates change between individuals according to the size of the sum involved and the length of waiting time period to get a certain amount. We followed the empirical analysis by Thaler (1981) by asking entrepreneurs the following question:

Q3. You have won a lottery whose prize is Euro 1,500 (25,000; 300,000). The bank asks you to wait for 1 month (1 year; 10 years). How much do you require to make waiting just as attractive as getting the money now?

Table 2 summarizes the median responses and in parentheses the continuously compounded discount rates implicit in the answers. As in Thaler (1981), implicit discount rates decrease substantially as the size of the prize increase or the length of time increases. The only exception occurs for the first column concerning a waiting period of 1 month where the rate for the amount of Euro 25,000 is lower than for 300,000.

Table 2 – Mean responses and continuously compounded discount rates in percent (in parentheses)

Amount of early prize	Later prize paid in		
	1 month	1 year	10 years
1,500	1,588 (151.4)	1,894 (26.2)	3,511 (2.4)
25,000	26,287 (80.7)	30,013 (22.4)	51,422 (1.8)
300,000	314,967 (114.7)	359,447 (18.9)	612,238 (1.6)

Source: Fondazione A.Merloni Survey and AIDA Bureau van Dijk

4. Empirical model and estimation procedure

In order to assess the effect of innovation on firm size growth, we adopt the firm growth model proposed by Evans (1987a, 1987b) augmented with the innovation dummy INNO. Denoting $g_{i,t}$ as the annual growth rate of the firm i at time t, we model variations in firm size depending on the age and size of firm at a previous time:

$$g_{i,t} = \alpha + \beta \ln SIZE_{i,t-1} + \gamma \ln AGE_{i,t-1} + INNO_{i,t} + u_{i,t} \qquad (1)$$

where $g_{i,t} = \ln SIZE_{i,t} - \ln SIZE_{i,t-1}$ and $\ln SIZE_{i,t}$ and $\ln SIZE_{i,t-1}$ are logarithmic sizes for firm i, respectively, at time t and t-1. Size is measured as annual net sales. The term $\ln AGE_{i,t-1}$ is age for firm i at time t-1. $INNO_{i,t}$ is a dummy variable for the occurrence of an innovation in year t in firm i where innovation corresponds to the release of a new product. As it is common with panel data, we allow for unobserved heterogeneity among firms. We introduce fixed firm effects which are possibly correlated with the right-hand side regressors. We obtain the following empirical firm growth model:

$$g_{i,t} = \alpha + \beta \ln SIZE_{i,t-1} + \gamma \ln AGE_{i,t-1} + INNO_{i,t} + \mu_i + u_{i,t} \quad (2)$$

where μ_i is a firm effect that corresponds to the permanent, unobserved heterogeneity of a particular nature of a firm’s production, but not within a firm over time.

Our interest is on the impact of the innovation term on firm size growth. We argued that the realization of an innovation is an endogenous choice reflecting firm's portfolio management. Firms engaged in strategic management of their product portfolios are more likely to introduce successful innovation given their attempt to allocate resource to their best use across products. We can control for this self selection effect by adopting a two step estimation procedure.[a] In the first step we estimate a linear probability model of observing a new product introduction:

$$INNO_{i,t} = \alpha + \phi X_{i,t-1} + \vartheta Z_{i,t-1} + v_{i,t} \quad (3)$$

where $X_{i,t-1}$ are observable control variables while $Z_{i,t-1}$ is a set of observable instrumental variables which are correlated with the endogenous variable $INNO_{i,t}$ but orthogonal to the error model u{i,t}of the basic equation 1. In the second step we replace these predicted probabilities of innovation, denoted by $I\hat{N}NO_{i,t}$, into equation 1:

$$g_{i,t} = \alpha + \beta \ln SIZE_{i,t-1} + \gamma \ln AGE_{i,t-1} + I\hat{N}NO_{i,t} + u_{i,t} \quad (4)$$

First stage estimates provide information about the factors influencing the decision to put forward a new product. We will examine the endogeneity of innovation to variables capturing firm's overall product portfolio strategy. We adopted the following set of instruments: lagged number of total products within portfolio (NPORTFOLIO) and lagged tenure of last new product released (TENURE). The rationale for the inclusion of NPORTFOLIO is based on the consideration that there is an optimum dimension of firm portfolio, consistent with the strategy of the firm, above which multi-product management becomes inefficient and firms have less incentive to introduce new products. With regard to the tenure of product, we follow Moral and Jamandreu (2007) which demonstrated that the age of the product is a relevant factor in defining product churning and the final composition of the product mix within the firm. All variables are in logarithms; the only exception is INNO which is a dummy variable, that takes the value of 1, if the firm had introduced a new product in year *t* and 0 otherwise. Finally, sector and time variables enter Equation 3 as control variables. Since we want to check whether risk attitude of decision makers affects the impact of innovation on firm growth performance, we run two separate regressions. We compare estimates of the firm growth model as function of INNO for the sub-samples of decision makers with a risk

[a] Different approaches are available to deal with endogeneity of innovation choice: the control function approach (Heckman) which requires strong assumptions about joint normality or alternatively; the GMM approach, which includes the lagged innovation variable as the instrumental variable. We preferred the IV approach since the estimation of the innovation equation at the first stage provided information about the influences of decision making of innovation. GMM is also very powerful with multiple endogenous variables.

aversion /discount rate indicator above and below the threshold corresponding to the sample mean of the indicator itself.

5. Results

We first compare the relation between innovation and firm growth under the two scenarios of exogenous and endogenous new product innovation. Then, we will provide evidence on the role of individual risk attitude and time preference on new product introduction and firm performance.

5.1 Endogenous product portfolio management and firm growth.

We first report results of the estimation of the sales growth model that we obtain by a fixed effect panel approach. Table 3, column I, shows that size exerts a negative effect on firm growth, while the coefficient of age is positive but not statistically significant.
Focusing on the impact of innovation, we observe that when the potential endogeneity on portfolio selection is neglected, the release of a new product has no significant effects on firm growth. Therefore, we re-estimate the growth model assuming that the firm's launch of a new product is endogenous. We argued that firm self select into new product as an effect of strategic allocation of resources among different goods according to the desiderated dimension and composition of product portfolio. In that scenario, risk attitude of decision maker can play a key role. Results are shown in Table 3, columns II-III.

Table 3 – Firm growth model. Fixed effect and 2SLS estimates.

	Fixed Effect	2SLS-Step 1	2SLS-Step 2
	(I)	(II)	(III)
Dependent variable	Sales Growth	Propensity to Innovation	Sales Growth
SIZE	-0.428***	0.003	-0.046**
	(-16.52)	(0.37)	(-2.51)
AGE	0.034	0.093***	-0.033**
	(0.55)	(7.22)	(-2.66)
INNO	-0.004		0.254*
	(-0.14)		(1.60)
TENURE		-0.147***	
		(-9.18)	
NPORTFOLIO		-0.099***	
		(-7.22)	
R-2	0.304	0.306	
Partial R-2 excluded instruments		0.294	
Test of excluded instruments		40.11***	
Test of overidentifying restrictions			0.169
N	944	944	944

Baseline: OECD Low-Technology Sectors, 1-10 Employees size class; individual firm legal form
Source: Fondazione A.Merloni Survey and AIDA Bureau van Dijk

First, we consider results of the first stage estimation procedure reported in column II. The coefficient of PORTFOLIO is negative and significant: the higher the number of products marketed by the firms, the lower the propensity to release a new product (there may be an optimum dimension of firm portfolio and that there are increasing management challenges of operating very large product portfolio, i.e. profitable diversification). The variable TENURE shows a negative and significant coefficient: the younger the product introduced, the more likely is the release of a new product. This finding can mirror features of a very innovative market, in which products become old very quickly. Coming to control variables, firm's age (AGE) is positively and significantly correlated with the introduction of a new product, whereas SIZE has no significant influence. Finally, there is no clear evidence that new product development is sector driven.[a] Column II of Table 3 reports results of the firm sales growth model which control for the endogeneity of the new product release (the second step of the estimation procedure). Once we control for endogeneity, the variable INNO returns a positive and significant coefficient: when firms strategically manage their own product portfolio, new product development promotes firm growth. The coefficient of size is positive and significant, whereas, contrary to Gibrat, we observe that bigger firms grow faster. The sign of the age term is negative and in accordance with Jovanovic. Finally, industry dummies do not influence firm growth. The Sargan test confirms the validity of the instruments employed.

5.2 Risk attitude, individual discount rates and firm growth performance.

To assess the role played by the risk attitude and individual discount rates of the decision makers, we run the previous model by distinguishing two sub-samples of decision makers according to their risk preference. As in Elston and Audretsch (2011), we use the sample mean as a threshold to split the two sub-samples. Table 4 reports the estimated results for the group of entrepreneurs split by risk attitude. Column I and IV show that the adoption of new products does not mirror the risk attitude of the entrepreneur in a fixed effect model of exogenous innovation. Conversely, the risk attitude parameter appears to play a role when the decision to introduce a new product is endogenized within a portfolio decision. Focusing on the variable of interest, i.e. INNO, risk-loving entrepreneurs seem to introduce products with a larger impact on firm growth than those chosen by risk-averse decision makers.

A possible interpretation of this results hinges on the presumption that their higher tolerance for risk allow them to select products with higher variability and/or hazard and, thus, expected returns. Since this decision is supported by a strategic revision of product portfolio, these products turn out to be successful once in the market.

Similarly, estimated results in Table 5 show that the introduction of high-potential products - that benefit firm growth substantially - is more likely to be observed by entrepreneurs with low discount rates, whereas short-term focused decision makers are more likely to select products with a lower impact on firm growth. Therefore, high return/high risk products may be preferred by more “patient” entrepreneurs who give higher weight to the long term success of the company.

[a] Tests reported at the end of Table 3 help to evaluate the goodness of the assumption of new product exogeneity and the validity of the chosen instruments. As for the endogeneity of innovation, we follow Davidson and MacKinnon augmented regression procedure. The predicted value of INNO into the estimation set of growth is significant. This can be taken as evidence of endogeneity and reveals that fixed effect estimates may be biased.

Table 4 – Firm growth model. Fixed effect and 2SLS estimates by risk attitude

	Risk averse decision makers			Risk loving decision makers		
	Fixed Effect	2sls Step 1	2sls Step 2	Fixed Effect	2sls Step 1	2sls Step 2
Dependent Variable	(I) Sales Growth	(II) Propensity to Innovation	(III) Sales Growth	(IV) Sales Growth	(V) Propensity to Innovation	(VI) Sales Growth
SIZE	-0.419***	-0.015	-0.033	-0.412***	0.008	-0.047*
	(-18.41)	(-1.21)	(-1.46)	(-11.44)	(0.81)	(-1.74)
AGE	0.057	0.094***	-0.024*	0.031***	0.122***	-0.039*
	(0.14)	(4.14)	(-1.68)	(6.18)	(4.84)	(-1.88)
INNO	0.098*		0.144	-0.070		0.355**
	(1.84)		(0.94)	(-1.32)		(1.71)
TENURE		-0.111			-0.164***	
		(-5.44)			(-7.21)	
NPORTFOLIO		-0.087			-0.136***	
		(-4.68)			(-7.99)	
R-2	0.440	0.311		0.498	0.312	
Partial R-2 excl.instr.		0.244			0.312	
Excluded instr.		21.47***			32.14***	
Overidentif. restr.			0.847			0.600
N	480	480	480	482	482	482

Baseline: OECD Low-Technology Sectors, 1-10 Employees size class; individual firm legal form
Source: Fondazione A.Merloni Survey and AIDA Bureau van Dijk

Table 5 – Firm growth model. Fixed effect and 2SLS estimates by discount rate

	High discount rate			Low discount rate		
	Fixed Effect	2sls Step 1	2sls Step 2	Fixed Effect	2sls Step 1	2sls Step 2
Dependent Variable	(I) Sales Growth	(II) Propensity to Innovation	(III) Sales Growth	(IV) Sales Growth	(V) Propensity to Innovation	(VI) Sales Growth
SIZE	-0.312***	0.027	-0.079*	-0.441***	-0.014	-0.044**
	(-8.44)	(1.22)	(-1.41)	(-8.00)	(-0.61)	(-2.88)
AGE	0.031	0.155***	-0.011	0.120	0.027***	-0.031**
	(0.28)	(8.24)	(-1.21)	(0.41)	(3.40)	(-2.90)
INNO	-0.030		-0.045	-0.029		0.240*
	(-0.47)		(-1.11)	(-0.24)		(1.87)
TENURE		-0.167***			-0.120***	
		(-9.12)			(-4.44)	
NPORTFOLIO		-0.123***			-0.111***	
		(-4.40)			(-3.89)	
R^2	0.233	0.401		0.262	0.248	
Partial R-2 excl.instr.		0.361			0.255	
Excluded instr.		30.14***			14.47***	
Overidentif. restr.			0.291			0.147
N	322	322	322	386	386	386

Baseline: OECD Low-Technology Sectors, 1-10 Employees size class; individual firm legal form
Source: Fondazione A.Merloni Survey and AIDA Bureau van Dijk

5.3 Robustness

It has been suggested that risk attitude differs between managers and owners. The common perception about the business orientation of managers within a firm is such that they engage predominantly in conservative and low-risk business strategy compared to owners. Consequently, our findings could mirror effects on firm performance tied to the ownership instead of the risk attitude of the decision makers. To avoid such misinterpretation, we run the model separately for the two samples of owners and managers (results are reported in Table 6). Focusing on the impact of INNO on firm growth, we found a not significant impact for both typologies of decision makers, i.e. owners and managers, on firm performance. Therefore, we are confident that our results are not driven by a concentration of risk-averse decision makers in the group of managers.

Table 6 - Entrepreneurs, managers, and firm growth models

	TP - Transformed price			
	Entrepreneurs		Managers	
	I step Propensity to innovation	II step Sales growth	I step Propensity to innovation	II step Sales growth
Size	–0.001	–0.048**	–0.002	–0.011
	(–0.16)	(–2.30)	(–0.25)	(–0.35)
Age	0.116***	–0.031*	0.072***	–0.019
	(5.08)	(–1.66)	(4.74)	(–0.98)
INNO		0.153		0.469
		(1.58)		(1.15)
Tenure	–0.173***		–0.101***	
	(–7.90)		(–6.08)	
Portfolio	–0.088***		–0.071***	
	(–4.61)		(–4.21)	
R2	0.378		0.248	
Partial R2 excluded instruments	0.336		0.210	
Test of excluded instrument	31.39***		19.27***	
Test of overidentifying restrictions		0.407		0.183
N	544	544	358	358

Notes: t-values in parenthesis; *,**,*** denotes significant at 10, 5, and 1%, respectively. All estimates include sector dummies, legal entity type dummies, past class of employment dummies, firm and industry ROA, year dummies, and constant.
Source: Fondazione A.Merloni Survey and AIDA Bureau van Dijk

6. Concluding remarks

Product portfolio management can be conceived as a strategy to cope with uncertainty and to release effective innovation for firm growth. Decision makers have to rely on subjective assessment of the commercial viability of their new product innovation. One fundamental influential factor of this assessment is the degree of risk aversion and the time-dependent individual discount rate of the decision maker. The paper evaluates if returns from new product introduction on firm growth differs according to the different risk attitudes of the decision makers. We try to evaluate the impact of the new product introduction on firm growth assuming that the new product emerges endogenously from a strategic management process in a multi-product firm. Individual risk attitude and individual discount rates play a key role in the portfolio selection process, as the decision to introduce a new product is an inherently risky decision.

Data on the individual risk attitude - elicited from a sample of 163 decision-makers - show that risk-loving individuals and individuals with smaller than average discount rates introduce products that affect firm growth rates significantly.

References

Andersen, S., Harrison, G.W., Lau, M.I. & Rutstrom, E.E. (2008) "Eliciting risk and time preferences" *Econometrica* 76(3): 583-618

Avlonitis G., Salavou H. (2007) "Entrepreneurial orientation of SMEs, product innovativeness and performance" *Journal of Business Research*, 60

Bernard A., Redding S. Schoot P. (2006) "Multi-products firms and products switching", NBER, Working Paper n.12293, June.

Binswanger H. (1981). "Attitudes towards risk: theoretical implications of an experiment in rural India" *The Economic Journal*, 91

Block, J.H., Sandner P.G. and Spiegel, F. (2009). "Do Risk Attitudes Differ Within the Group of Entrepreneurs?" Available at SSRN: http://ssrn.com/abstract=1473989

Busenitz L.W., Barney J.B. (1997) "Differences between entrepreneurs and managers in large organizations: biases and heuristics in strategic decision-making" *Journal of Business Venturing*, 12: 9-30

Cramer J. Hartog J., Jonker N., Van Praag C. (2002) "Low risk aversion encourages the choice for entrepreneurship: an empirical test of a truism" *Journal of Economic Behaviour and Organisation*, 48, 29-36

Crawford, M., Di Benedetto, A. (2006). *New Product Management*, Eight ed. McGraw-Hill, New York.

Cruz C., Nordqvist M. (2010). "Entrepreneurial orientation in family firms: a generational perspective". *Small Business Economics*, 21.3

Dixit, A., Pindyck, R. (1994). *Investment under uncertainty*. Princeton University Press, Princeton.

Elston J, Audretsch D. (2011). "Financing the Entrepreneurial Decision: An Empirical Approach Using Experimental Data on US High Technology Entrepreneurs. *Small Business Economics*. 36(2):209-222

Elston, J, Audretsch D. (2010). "Risk attitudes, wealth and sources of entrepreneurial start-up capital" *Journal of Economic Behavior & Organization*, Volume 76, Issue 1, October 2010, Pages 82–89

Fisher N., Hall G.R. (1969) "Risk and corporate rates of returns", *Quarterly Journal of Economics*, 83: 79-92

Forlani D., Mullins J. (2000) "Perceived risks and choices in entrepreneurs' new venture decisions" *Journal of Business Venturing*, 15, 305-322

Gifford, S., 2003, "Risk and Uncertainty", in *Handbook of Entrepreneurship Research. An Interdisciplinary Survey and Introduction*, Edited by Acs Z.J., Audretsch D.B., Springer, New York.

Hartog J., A. Ferrer-i Carbonell Jonker N. (2002) "Linking measured risk aversion to individual characteristics", *Kyklos*, 55

Harrison G.W., Lau M.I., Rutström E.E. (2007) "Estimating risk attitudes in Denmark: a field experiment" *Scandinavian Journal of Economics*, 109 (2)

Harrison, G.W., Lau, M.I. & Rutström, E.E. (2010) "Individual Discount Rates and Smoking: Evidence From a Field Experiment in Denmark", *Journal of Health Economics* 29(5): 708-717.

Hugonnier J., Morellec E. (2007) "Corporate control and real investment in incomplete markets" *Journal of Economic Dynamics & Control*, 31, 1781–1800

Keh, H.T., M.D. Foo and B.C. Lim. (2002) "Opportunity evaluation under risky conditions: the cognitive processes of entrepreneurs" *Entrepreneurship: Theory and Practice* 27 (2) 125-148.

Kihlstrom, R.E. and Laffont, J.J. (1979) "A general equilibrium entrepreneurial theory of new firm formation based on risk aversion" *Journal of Political Economy* 87, pp. 304–316.

March J.G., Shapira Z., (1987) "Managerial perspectives on risk and risk taking" *Management Science*, 33(11)

Moral, M.J., Jaumandreu, J., (2007) "Automobile demand, model cycle and age effects" *Spanish Economic Review* 9, 193–218.

Mu J., Peng G., Maclachlan D. (2009), "Effect of risk management strategy on NPD performance" *Technovation*, 29

Naldi L., Nordqvist M., Sjoberg K., Wiklund J. (2007) "Entrepreneurial orientation, risk taking and performance in family firms" *Family Businiess Review*, 20:1

Norton W., Moore W. (2006) "The influence of entrepreneurial risk assessment on venture launch or growth decisions" *Small Business Economics*, 26

Palich L.E. , Bagby D.R. (1995) „Using cognitive theory to explain entrepreneurial risk taking: challenging conventional wisdom" *Journal of Business Venturing*, 10: 425-438

Rauch, A., Wiklund, J., Frese, M., Lumpkin, G. T., (2004) "Entrepreneurial Orientation and Business Performance: Cumulative Empirical Evidence", Paper presented at the *Babson Kauffman, Entrepreneurship Research Conference (BKERC)*, Glasgow.

Reynolds, P.D., Bygrave, W.D., Autio E. (2002). *GEM 2002 Executive Report*. London: Kauffman Foundation.

Sauner-Leroy J.B. (2004) "Managers and productive investment decisions: the impact of uncertainty and risk aversion" *Journal of Small Business Management*, 42 (1)

Soderbom M., Pattillo C. (2000) "Managerial risk attitude and firm performance in Ghanaian manufacturing: an empirical analysis based on experimental data", *CSAE – UNIDO* WP 3

Tan, J. (2001) "Innovation and Risk-Taking in a Transitional Economy: A Comparative Study of Chinese Managers and Entrepreneurs" *Journal of Business Venturing* 16(4): 359-376

Tyagi R.(2006) "New product introduction and failure under uncertainty" *International Journal of Research in Marketing*, 23

Thaler R. (1981) "Some empirical evidence on dynamic inconsistency" *Economics Letters*, 8, 201-207

Wachter, J. A. (2003) "Risk aversion and allocation to long-term bonds" *Journal of Economic Theory*, Elsevier, vol. 112(2), pages 325-333, October

Wagner J. (2005) "Nascent Necessity and Opportunity Entrepreneurs in Germany. Evidence from the Regional Entrepreneurship Monitor (REM)". *Labor and Demography* 0506004, EconWPA.

Walls M., Dyer J. (1996) "Risk propensity and firm performance: a study of the petroleum exploration industry" *Management Science*, 42:7

Van Praag B., Booij A. (2003) "Risk aversion and the subjective time discount rate: a joint approach", *CESIFO* WP n. 923

Weber E., Blais A.R., Betz N. (2002) "A domain-specific risk-attitude scale: measuring risk perception and risk behaviours" *Journal of Behavioural Decision Making*, 15
Verbeek M. (2000). *Modern econometrics*. Wiley.
Zahra S. (2005). "Entrepreneurial risk taking in family firms". *Family Business Review*, 18:1.

Table A1. Variable definition and descriptive statistics (n=163)

Variable		mean	sd	min	max
Growth	Annual firm sales growth (log)	0.062	0.188	–1.589	2.149
Sales	Firm sales (log)	9.438	0.879	6.571	12.129
Age	Firm age (log)	3.444	0.528	1.792	4.820
INNO	New product introduction dummy (1=innovation occurs; 0=otherwise)	0.022	0.147	0.000	1.000
Tenure	Years since latest product introduction (log)	3.004	0.813	0.693	4.836
Portfolio	Number of products in portfolio (log)	0.428	0.500	0.000	1.386
TPB	Risk attitude–Transformed price	0.492	0.461	–1.500	0.999
ROA	Return on assets	0.059	0.073	–0.436	0.408
Pavitt1	Pavitt sector: Supplier dominated (ref.cat.)	0.494	0.500	0	1
Pavitt2	Pavitt sector: Scale intensive	0.185	0.389	0	1
Pavitt3	Pavitt sector: Specialized suppliers	0.185	0.388	0	1
Pavitt4	Pavitt sector: Science based	0.135	0.342	0	1
Legalent1	Individual firm (ref. category)	0.062	0.241	0	1
Legalent2	Joint stock company	0.421	0.494	0	1
Legalent3	Limited private company	0.517	0.500	0	1
Clemp1	Employees size class: 1–19 (ref.category)	0.031	0.173	0	1
Clemp2	Employees size class: 20–49	0.271	0.444	0	1
Clemp3	Employees size class: 50–149	0.421	0.494	0	1
Clemp4	Employees size class: 150–249	0.245	0.430	0	1
Clemp5	Employees size class: more that 250	0.032	0.176	0	1

Source: A. Merloni Foundation Survey

Table A2. Firm growth model. 2SLS estimates by measures of risk attitude

2SLS	TPB (risk attitude)				Individual discount rate			
Dependent variable	Step 1	Step 2	Step 1	Step 2	Step 1	Step 2	Step 1	Step 2
	Propensity to Innovation	Sales Growth	Propensity to Innovation	Sales Growth	Propensity to Innovation	Sales Growth	Propensity to Innovation	Sales Growth
Size	-0.004	-0.022	-0.004	-0.016	-0.012	-0.018	-0.029	-0.024
	(-0.67)	(-1.35)	(-0.61)	(-1.28)	(-0.84)	(-1.12)	(-0.64)	(-1.06)
Age	0.091***	-0.025**	0.089***	-0.072***	0.087***	-0.027**	0.114***	-0.041**
	-7.07	(-2.41)	-8.11	(-3.37)	-6.91	(-3.14)	-8.84	(-2.98)
INNO		0.295**		0.344**		0.281**		0.306***
		-1.95		-2.02		-2.07		-4.01
Tenure	-0.144***		-0.144***		-0.141***		-0.103***	
	(-8.98)		(-8.11)		(-9.91)		(-7.55)	
Nportfolio	-0.088***		-0.086***		-0.086***		-0.047***	
	(-6.02)		(-5.44)		(-6.44)		(-8.23)	
TPB	-0.002	-0.006	-0.029	0.026				
	(-0.31)	(-0.51)	(-0.84)	-1.04				
INNO*TPB				-0.213**				
				(-2.07)				
Individual discount rate					-0.011	-0.124	-0.004	-0.051
					(-0.84)	(-0.46)	(-0.16)	(-0.48)
INNO*Discount rate								-0.266***
								(-7.31)
R^2		0.284		0.322		0.281		0.318
Partial R^2 excl.instr.		0.266		0.311		0.272		0.333
Test of excl.instr.		38.12***		39.44***		41.18***		46.22***
Overidentifying restr.		0.181		0.206		0.184		0.19
N		866		866		857		857