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Gabriele Pellegrino, SPRU, University of Sussex

Mariacristina Piva, Dipartimento di Scienze Economiche e Sociali, Università Cattolica del Sacro Cuore, Piacenza (corresponding author)

Marco Vivarelli, Istituto di Politica Economica, Università Cattolica del Sacro Cuore, Milano - SPRU, University of Sussex - IZA, Bonn

✉ gabriele.pellegrino@unicatt.it

✉ mariacristina.piva@unicatt.it

✉ marco.vivarelli@unicatt.it

I quaderni possono essere richiesti a:
Istituto di Politica Economica, Università Cattolica del Sacro Cuore
Largo Gemelli 1 – 20123 Milano – Tel. 02-7234.2921

✉ ist.politicaeconomica@unicatt.it

www.vitaepensiero.it

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Abstract

This paper analyses the determinants of product innovation in Italian young innovative companies (YICs) by looking at in-house and external R&D and at the acquisition of external technology in its embodied and disembodied components. A Tobit approach is applied to study jointly the occurrence of product innovation and the intensity of such innovation.
Results provide evidence that in-house R&D is linked to product innovation both in mature firms and YICs; however, YICs turn out to be less in-house R&D-based and more dependent on external sources of knowledge. Moreover, other entrepreneurial attitudes such as the ability to cooperate with other firms in producing innovation or the capacity to develop significant organizational changes appear to be less important or even absent in Italian YICs. These results are somehow worrying, since they show that Italian innovative entrepreneurs are mostly driven by routinized rather than creative strategies.

Keywords: YICs; entrepreneurship; R&D; product innovation.
JEL Classification: L26, O31.

1. Introduction

Both the academic community and policy makers have shown increased awareness of the role of young innovative companies (YICs) run by entrepreneurs who should contribute to the renewal of the industrial structure and ultimately to economic growth[1]. Following this approach, one of the possible explanations of the productivity gap among US and Europe could depend on the revealed capacity of the US economy to generate an increasing flow of young innovative firms which survive introducing new products and gaining a place at the core of emerging sectors[2]. On the contrary, young European firms show a lower innovative capacity and a higher business failure rate, not contributing to the alleged positive innovative industrial dynamics (see Bartelsman *et al*., 2004; Santarelli and Vivarelli, 2007; Vivarelli, 2013). In this context, the European economy would appear to lack innovative and creative founders, who are the core of the so-called 'entrepreneurial society' (Audretsch and Thurik, 2000; Audretsch, 2007).

When deciding their 'Knowledge Production Function' (see Section 2), innovative entrepreneurs face different options: as well as in-house and external R&D activities, technological acquisition (TA) in its embodied (machinery and equipment) and disembodied components has to be taken into account. A first issue investigated in this paper is whether YICs are more or less R&D-based than their older counterparts. Together with this basic research question, other entrepreneurial characteristics, such as risk aversion, attitude towards organizational change and the capacity to develop cooperative innovation will be studied to test whether any significant differences emerge between YICs and mature incumbents.

The rest of the paper is structured as follows: a discussion of the reference literature is presented in Section 2, whereas the description

[1] For example, several EU member states have introduced new measures to support the creation and growth of YICs, especially by improving their access to funding (see BEPA, 2008; Schneider and Veugelers, 2010).

[2] For complementary interpretations of the transatlantic productivity gap, see Ortega-Argilés *et al*.(2011) and Ortega-Argilés *et al.* (2014).

of the data used in the empirical analysis follows in Section 3. Subsequently, the econometric results are displayed and discussed in Section 4. Section 5 concludes the paper by briefly summarising the main findings and suggesting policy implications.

2. The literature

The first contributions to introduce the innovative input-output relationship were put forward by Griliches (1979 and 1990), by the means of a three-equation model in which one of the equations is called Knowledge Production Function (KPF), a function representing the transformation process from innovative inputs (R&D) to innovative outputs (patents). The KFP is also included in the models provided by Crèpon *et al*. (1998) and Lööf and Heshmati (2001). However, in most of these previous empirical studies, the KPF is simplified as a link between R&D and patents.

Historically driven by relative data availability, the relationship between a firm's R&D investment and patenting activity leaves room for a more complete approach to the determinants of innovation. Today, innovation surveys offer more comprehensive measures of both innovative inputs and outputs.

Consistently, different innovation outputs, such as product and process innovation, can be seen as the outcomes of several innovation inputs. Beside the formal R&D investment [3], technological acquisition plays a role through 'embodied technical change'[4] - acquired by means of investment in new machinery and equipment -, and through the purchasing of external technology incorporated in licences, know-how and consultancies (Freeman, 1982; Freeman *et al.*, 1982; Freeman and Soete, 1987). Once it has

[3] Methodologically, this is well represented by the shift from the R&D-focused Frascati Manual ('Guidelines for the collection of R&D data', first published in 1963) to the Oslo Manual, published in the 1990s (OECD, 1997).

[4] The embodied nature of technological progress was originally discussed by Salter (1960) and Solow (1960); in particular, vintage capital models describe an endogenous process of innovation in which the replacement of old equipment is the main way through which firms update their own technologies (see also Jorgenson, 1966; Hulten, 1992; Greenwood *et al.* 1997; Hercowitz, 1998).

been recognized that innovative inputs are not confined to formal R&D and that innovative outputs can be measured by indicators other than patent (such we pave the way for a deeper analysis of peculiarities in the KPF[5]. In particular, when innovation is carried out by an entrepreneur leading a young firm, we can think of R&D as a creative input where endogenous competences are fully deployed in generating product innovation (Teece, *et al.* 1997; Von Tunzelmann and Wang, 2003 and 2007), while technological acquisition appears to be more related to the implementation of external knowledge, with replication and imitation playing a crucial role. Moreover, those entrepreneurs relying more on R&D not only create value from their present capabilities but also pave the way to better absorbing new ideas coming from the external environment (the so-called 'absorptive capacity', see Cohen and Levinthal, 1989 and 1990).

Hence, as a first issue of investigation we wonder whether innovative entrepreneurs differ from mature incumbents in their input-output innovative relationships. Are new innovative companies more R&D-based and able to drive a science-based reorientation of the current industrial structure?[6] Or, on the contrary, are YICs less strong than the innovative incumbents and basically dependent on external knowledge provided by larger mature firms and research institutions?

The hypothesis that newly established firms are more R&D-based is consistent with the Schumpeterian 'creative destruction' (Schumpeter, 1934; the so-called Schumpeter Mark I), while the process of 'creative accumulation' requires large and established

[5] See Nelson and Winter (1982) and Dosi (1988) for an extended and more articulated view of the innovative process across firms.

[6] This seems to be the view implicitly accepted in the literature on the so-called 'New Technology Based Firms' (NTBFs, see Storey and Tether, 1998; Colombo and Grilli, 2005), where only YICs in the high-tech sectors are analyzed; in contrast, in this paper YICs across all manufacturing sectors are studied. While in this study we compare innovative entrepreneurs with mature innovative incumbents, a related stream of literature investigates the role of innovation in facilitating the entry and post-entry performance of newborn firms (see Audretsch and Vivarelli, 1996; Cefis and Marsili, 2006).

firms to lead the innovative process (Schumpeter, 1942; Schumpeter Mark II). In the former context, an 'entrepreneurial regime' is at work (using an evolutionary terminology), where innovative entrepreneurs are the main factors of change, while the latter is a 'routinized regime', where larger and older incumbents are the engines of change leading the innovative process (see Winter, 1984; Malerba and Orsenigo, 1996; Breschi *et al.*, 2000).

Indeed, when as in this study we focus on all the industrial sectors and not only on the emerging or the high-tech ones, several arguments support larger mature firms being more R&D-based than their younger counterparts. First of all, mature incumbents do not suffer from liquidity constraints as they generally have privileged access to external finance and internal funds to support R&D activities. Secondly, incumbent firms enjoy a higher degree of 'appropriability', as they usually possess more market power (Gilbert and Newbery, 1982). Finally, learning economies (see Arrow, 1962; Malerba, 1992) are often crucial in innovative dynamics, and younger inexperienced entrepreneurs are obviously at a disadvantage from this perspective.

However, not all innovative firms are large established corporations. Indeed, economic literature supports the hypothesis that new firms face a different technological and economic environment from large mature incumbents with respect to innovative activities (see Acs and Audretsch, 1988 and 1990; Acs *et al.*, 1994). Indeed, it may well be the case that entrepreneurial YICs establish their competitive advantage on the basis of creative and R&D-based product innovation, which significantly increases both their chances of survival and their economic performance in comparison with less innovative start-ups (see Arrighetti and Vivarelli, 1999; Michelacci, 2003; Cefis and Marsili 2005).

In addition to the investigation of the peculiarities of the KPF in YICs, a second issue of interest in this work is to see whether other characteristics can significantly affect firms' overall innovative performance. In particular - taking into account both the previous literature and data availability - we will assume product innovation (both in terms of its occurrence and its intensity) as an indicator of

innovative performance, and we will assess the role of different determinants in affecting the level of product innovation. The KPF baseline approach (see above) will be complemented by the investigation of five additional factors, as follows.

Firstly, we will check the role of a firm's size to see whether the Schumpeterian hypothesis, which claims an advantage of larger firms in introducing innovation (see the classical debate started by Schumpeter, 1942; renewed by Arrow, 1962 and more recently continued in Cohen and Klepper, 1996), is supported across both the incumbents and the YICs.

Secondly, the role of sectoral belonging will be studied using Pavitt's taxonomy (see Pavitt, 1984; Malerba and Orsenigo, 1996; Malerba, 2005). With regard to YICs, it will be interesting to see whether the 'science-based' and the 'specialised supplier' (the high-technology groups in Pavitt's taxonomy) young firms enjoy a relative advantage in developing their innovative products.

Thirdly, we will test the role of risk aversion in deterring entrepreneurial innovative behaviour (see Kihlstrom and Laffont, 1979; Palich and Bagby, 1995; Parker, 2004; Kan and Tsai, 2006): since innovation is a costly and uncertain activity, are firms – especially YICs – limited by their own risk aversion? Since risk aversion and entrepreneurship are inversely correlated, this will be a first direct way to test the role of entrepreneurship in shaping innovative performance (both in general and with specific reference to the young innovative companies).

Fourthly, organizational change will be considered as a second indicator of entrepreneurial capability[7]. On the one hand, many scholars have investigated the complementarity between technological and organizational change (see, for instance, Bresnahan *et al.*, 2002; Hitt and Brynjolfsson, 2002; Piva *et al.*, 2005). On the other hand, the role of an entrepreneur is precisely that of creatively combining the different factors of production (see Kirzner, 1997). Thus, entrepreneurial firms, able to introduce

[7] In this case, in contrast with risk aversion, organizational change is positively correlated with the entrepreneurial ability.

organizational changes (specifically, entrepreneurial YICs) should be better positioned to generate product innovation.

Fifthly, a third indicator of entrepreneurship adopted in this study is the ability to cooperate with other firms in joint innovative activities. Cooperative innovation has indeed been shown to be crucial in determining better innovative performance across firms (see Cassiman and Veugelers, 2002; Piga and Vivarelli, 2003 and 2004; Fritsch and Franke, 2004; Parker, 2008; Cefis *et al*., 2009). Here we will see whether this entrepreneurial ability turns out to be significant in explaining the differences in innovative performance across firms and, more specifically, across YICs.

Summing up, this paper will investigate the innovation strategies adopted by entrepreneurs in the initial stages of their firm's life cycle, and will compare them with what is done by mature older incumbents. The first hypothesis is that YIC innovative strategies based on internal R&D are more consistent with a 'creative destruction' role of new entrepreneurs, while YIC innovation based on technological acquisition would be more consistent with a routinized regime of 'creative accumulation', mostly driven by incumbent companies. The second hypothesis is that size, sectoral belonging and various entrepreneurial attitudes should significantly affect both the occurrence and the intensity of product innovation.

3. Database, variables and methodology

3.1. Database

The empirical analysis was carried out using firm-level data from the third Italian Community Innovation Survey (CIS3)[8], conducted over the 1998-2000 period by the Italian National Institute of Statistics (ISTAT). This survey is representative at both sector and

[8] Given the aims and scope of this paper, attention has been limited to the manufacturing sectors.

firm size level of the entire population of Italian firms with more than 10 employees [9] (ISTAT, 2004).

The response rate was 53%, determining a full sample size of 15,512 firms, 9,034 of which (58.24%) in the manufacturing sector, our focus of attention. The manufacturing sample was then cleaned of outliers and firms involved in mergers or acquisitions during the previous three years, which would have biased our results[10]. We thus ended up with 7,965 innovating and not-innovating firms.

The sub-sample of innovators was then selected following the standard practice of identifying innovators as those firms declaring that in the previous three years they had introduced either product or process innovations, or had started innovative projects (then dropped or still-to-complete at December 31st, 2000). The same definition was implemented by ISTAT as a filter to single out non-innovators that were allowed to skip a large number of 'innovation questions', leaving us with very little information about their propensity to innovate or to invest in innovative inputs. This means that the CIS database provides information relevant to this study only for innovative firms; therefore only these firms have been considered in

[9] Firm selection was carried out through a 'one step stratified sample design'. The sample in each stratum was selected with equal probability and without reimmission. The stratification of the sample was based on the following three variables: firm size, sector, regional location. Technically, in the generic stratum h, the random selection of n_{h} sample observations among the N_{h} belonging to the entire population was realized through the following procedure:
- a random number in the 0-1 interval was attributed to each N_h population unit;
- N_h population units were sorted by increasing values of the random number;
- units in the first n_h positions in the order previously mentioned were selected.
Estimates obtained from the selected sample are very close to the actual values in the national population. The weighting procedure follows Eurostat and Oslo Manual (OECD, 1997) recommendations: weights indicate the inverse of the probability that the observation is sampled. Therefore, sampling weights ensure that each group of firms is properly represented and correct for sample selection. Moreover, sampling weights help to reduce heteroscedasticity commonly arising when the analysis focuses on survey data.

[10] In fact, mergers and acquisitions may break the link between innovative inputs and outputs (a link that must be studied within the context of the same economic entity over time).

the following analysis[11], ending up with 3,045 firms. This sample was further reduced to 2,713 firms by keeping only firms investing in at least one of the four innovative inputs we focus on and whose age was available. Finally, YICs were identified as innovative firms which had been operational for less than eight years (293 out of 2,713)[12].

3.2. Innovative variables

Innovative variables capture innovative output and innovative inputs.

With regard to *innovative outputs* they can be distinguished with respect to their position in the innovation process. For instance, while patents are better defined as the outcome of the inventive process, product innovation represents the result of the market-oriented innovative process. However, even though product innovation is driven by demand considerations, it represents a pre-market result. In contrast, the share of sales deriving from innovative products (Lööf and Heshmati, 2002; Mairesse and Mohnen, 2002), the intensity of innovation, represents an *ex-post* result in which the market has positively welcomed the new products introduced by the firm (Barlet *et al.,* 2000). This paper uses the *ex-post* result as the output indicator for the empirical analysis, i.e. the share of turnover (sales) derived

[11] Given that our aim is to analyze the nature of the relationships within the innovative process (and not, for example, the effect of different inputs in determining the probability of innovating), this data limitation does not raise a problem of selection bias in our context. Since we are interested in the internal mechanisms of the innovative process, we have to focus on a randomly-selected sample of innovative firms (that is, randomness must hold *within* the innovative sub-sample, not in comparison with the non-innovative one where such mechanisms are obviously absent). For a study based on a comparison *between* innovative and non-innovative Italian firms, see Parisi *et al.* 2006.

[12] As far as the age of the firms in the 'young firms' sub-sample is concerned, the threshold of 8 years was chosen to take into account the trade-off between a lower age and the representativeness of the sub-sample of YICs (here more than 10% of the entire sample). However, the estimates discussed in Section 4 were replicated using a larger sample of young firms no more than 10 years old. The results, available from the authors upon request, do not change substantially.

from innovative products (TURNIN). This is the only continuous output indicator provided by the CIS. Finally, it is also important to note that product innovators are a subsample of the innovative firms considered in this study, since they do not include those firms only engaged in process innovation or those involved in potential innovative projects. As a consequence, our TURNIN indicator is a double-censored variable with a mass of values equal to zero.

Looking at the *innovative inputs*, four innovative inputs are used in this paper:

- in-house formal Research and Development (intra muros R&D = IR);
- Research and Development outsourced to other firms or research institutes (extra muros R&D = ER);
- expenditures in embodied technological change (innovative investment in equipment and machinery = MAC);
- expenditures in technology acquisition (disembodied technology such as know-how, projects and consultancies, licenses and software = TA).

3.3. Other characteristics/variables

Taking into account the reference literature and the hypotheses discussed in Section 2, attention will be paid to the following additional variables:

- firm size, measured by the number of employees (SIZE), in order to test the Schumpeterian hypothesis;
- as discussed in Section 2, the important role of sectoral belonging will be tested using Pavitt's sectoral dummies,

controlling for the different sectoral technological opportunity and appropriability conditions[13];

- turning our attention to the entrepreneurial variables, RISK will measure risk aversion using a YES/NO (1/0) questionnaire reply centered on the role of perceived risk as an important obstacle to innovative activities;
- the entrepreneurial attitude towards organizational change will be implemented through the dummy ORG, assuming value 1 when the innovative firm has introduced a significant organizational change at the strategic, management or shopfloor level;
- finally, the firm's attitude towards cooperation will be measured by the dummy COOP, assuming value 1 when the innovative firm is engaged in innovative cooperation with other firms.

The summary Table 1 describes the variables used in the empirical analysis, while Table 2 reports the corresponding descriptive statistics, distinguishing between all firms, mature firms and YICs[14].

[13] The estimates will include three groups: science-based, specialised supplier and scale intensive firms, where the default category will be the low-technology group of the supplier dominated firms.

[14] In the Appendix, Table A1 reports the correlation matrix; as can be seen, all the correlation coefficients are less than 0.245, showing that data are not affected by serious collinearity problems. Finally, Table A2 reports the CIS questions on the basis of which the variables were constructed.

Table 1 - *The variables*

TURNIN	Share of firm's total sales due to sale of new products
IR	Internal R&D expenditure in 2000, normalized by total turnover
ER	External R&D expenditure in 2000, normalized by total turnover
MAC	Investments in innovative machinery and equipment in 2000, normalized by total turnover
TA	Technological acquisitions in 2000, normalized by total turnover
SIZE	Number of employees in 2000
SB	Dummy = 1 if science-based firm
SI	Dummy = 1 if scale intensive firm
SS	Dummy = 1 if specialized supplier firm
RISK	Dummy = 1 if firm has perceived high economic risk from the decision to innovate
ORG	Dummy = 1 if the firm has realized managerial, strategic or organizational innovation
COOP	Dummy = 1 if the firm takes part in cooperative innovative activities

Table 2 - *Descriptive statistics*

	ALL FIRMS 2,713 OBS		MATURE FIRMS 2,420 OBS		YOUNG FIRMS (YICs) 293 OBS	
	MEAN	SD	MEAN	SD	MEAN	SD
TURNIN	0.30	0.29	0.30	0.29	0.34	0.32
IR	0.013	0.026	0.013	0.025	0.014	0.032
ER	0.002	0.009	0.002	0.008	0.002	0.011
MAC	0.035	0.078	0.034	0.076	0.042	0.091
TA	0.002	0.018	0.002	0.017	0.004	0.023
SIZE	175.023	633.797	182.629	666.530	112.201	214.542
SB (*dummy*)	0.116	0.320	0.113	0.316	0.140	0.347
SI (*dummy*)	0.284	0.451	0.282	0.450	0.300	0.459
SS (*dummy*)	0.280	0.449	0.282	0.450	0.266	0.443
RISK (*dummy*)	0.544	0.498	0.545	0.498	0.539	0.499
ORG (*dummy*)	0.721	0.449	0.714	0.452	0.778	0.416
COOP (*dummy*)	0.161	0.368	0.162	0.369	0.150	0.358

Table 3 reports the sectoral compositions of the two subsamples of mature and young firms; as can be seen, with regard to the four Pavitt (1984) categories, no significant differences emerge; indeed, a slight over-representation of science-based firms in the YIC subsample is compensated for by a lower presence of the specialised supplier ones. On average, Italian YICs belong to the same sectors as mature incumbents. Thus NTBFs do not represent the core of Italian YICs, and the contribution to sectoral renewal by the new and young innovative firms appears rather limited. Not surprisingly, YICs turn out to be relatively smaller (112 employees on average) than their older counterparts (183 employees)[15].

[15] As discussed at in Section 3, the CIS3 data adopted are collected from a representative sample of Italian manufacturing firms with more than 10 employees;

Table 3 - *Sectoral composition and average employment of the firms belonging to the two subsamples: Mature and Young firms*

INDUSTRY PAVITT TAXONOMY	MATURE FIRMS			YOUNG FIRMS (YICs)		
	N. of firms	%	Av. Emp	N. of firms	%	Av. Emp
Science-based (SB)	273	11.28	296.52	41	14	165.29
Scale Intensive (SI)	683	28.22	192.74	88	30.03	95.02
Specialized Suppliers (SS)	683	28.22	179.43	78	26.62	131.13
Supplier Dominated (SD)	781	32.27	136.77	86	29.35	87.30
SAMPLE	2,420	100	182.63	293	100	112.20

3.4. The econometric model

Equation (1) describes the general complete specification of the model:

$$TURNIN_i = C + \beta_1 IRint_i + \beta_2 ERint_i + \beta_3 MACint_i + \beta_4 TAint_i + \beta_5 SIZE_i + \sum\gamma_k PAVITT_{ki} + \beta_6 RISK_i + \beta_7 ORG_i + \beta_8 COOP_i + \varepsilon_i \quad \textbf{(1)}$$

where C is the constant, i is the firm-index, TURNIN represents the innovative output in terms of the percentage of sales due to innovative products, IR, ER, MAC and TA indicate the innovative

this means that micro firms (which however are very rarely innovative) are excluded from the dataset, while SMEs are fully included.

inputs we are interested in, SIZE, RISK, ORG and COOP are the variables we want to check for and PAVITT are the sectoral dummies (k=3). Consistently with the dependent variable, the four innovative inputs were normalized by sales; this makes the inputs homogeneous to the output.

Dealing with a zero-inflated censored variable, estimates were run as Tobit regressions.

4. Econometric results

Table 4 reports the econometric results of the Tobit model applied to the entire sample and separately to the two sub-samples of the mature incumbents and the YICs. This first baseline specification only reports the four knowledge inputs and the size and Pavitt controls.

As can be seen (and consistently with previous studies based on Italian data, Parisi *et al.* 2006; Conte and Vivarelli, 2014), in-house R&D is important in increasing product innovation for the entire sample, the mature firms and the YICs. Indeed, R&D input is more directly related to product innovation, while embodied technological change (MAC) is more linked to process innovation (see Freeman, 1982; Freeman and Soete, 1987)[16]. However, a closer look reveals some interesting differences between mature firms and YICs.

[16] This also explains the negative and significant coefficient of MAC in the estimate referring to the incumbents (second column of Table 4).

Table 4 - *Baseline Specification*

	ALL FIRMS	MATURE FIRMS	YOUNG FIRMS (YICs)
Dependent variable: TURNIN			
Constant	0.19***	0.19***	0.20***
	(14.73)	(14.17)	(4.60)
IR	2.17***	2.25***	1.81**
	(7.97)	(7.59)	(2.54)
ER	0.91	0.56	2.23
	(1.12)	(0.62)	(1.16)
MAC	-0.18*	-0.29***	0.42*
	(-1.88)	(-2.89)	(1.68)
TA	-0.23	-0.33	0.27
	(-0.56)	(-0.74)	(0.28)
SIZE	0.00	0.00	0.00
	(1.22)	(1.32)	(0.29)
SB	0.12***	0.10***	0.22***
	(4.78)	(3.82)	(2.94)
SI	-0.03	-0.03	-0.05
	(-1.49)	(-1.35)	(-0.90)
SS	0.10***	0.10***	0.09
	(5.82)	(5.51)	(1.45)
N. of firms	2,713	2,420	293
Censored (TURNIN = 0)	615	550	65
Uncensored	2,098	1,870	228

Notes
t- statistics in parentheses: * Significant at 10%; ** 5%; *** 1%

Firstly, the in-house R&D coefficient is smaller in magnitude and less significant in the case of the YICs[17]. Secondly, the three external sources of knowledge turn out to be either negative or not significant for the whole sample, while positive and in one case (MAC) barely significant in the case of the young firms. Putting these two outcomes together, we can conclude that Italian YICs, far from being R&D-based NTBFs, are relatively biased in favour of embodied technological change and less R&D intensive than their older counterparts. Together with what emerges from Table 3 above, these results confirm the hypothesis that Italian YICs are not particularly creative and autonomous in shaping their innovative KPFs. Instead, like the vast majority of Italian SMEs (see Santarelli and Sterlacchini, 1990 and 1994), they turn out to be relatively less R&D-based and more dependent on external sources of knowledge.

Turning our attention to size and sectoral controls, the Schumpeterian hypothesis is not supported by our estimates, the relative coefficient not being significantly different from zero. Not surprisingly, the science-based and specialised supplier firms (the two high-tech categories in Pavitt's taxonomy) are significantly more inclined to product innovation and this is true both for the entire sample and for the mature firms. Interestingly enough, with regard to YICs, only the SB dummy turns out to be significant, with a coefficient that is more than twice the corresponding one for the mature firms. This means that for YICs it is even more important to belong to the science-based category, in order to obtain an above-average innovative outcome. This result makes the descriptive evidence reported in Table 3 even more worrying: if the majority of Italian YICs were NTBFs belonging to the SB sectors (which is not the case), their innovative performance would be significantly higher.

[17] This outcome is consistent with what found by Pellegrino *et al.* (2012), using a different specification and a different econometric methodology.

Table 5 - *Extended Specification*

	ALL FIRMS	**MATURE FIRMS**	**YOUNG FIRMS (YICs)**
Dependent variable: TURNIN			
Constant	0.12***	0.13***	0.12*
	(6.75)	(6.66)	(1.95)
IR	1.99***	2.05***	1.74**
	(7.32)	(6.93)	(2.45)
ER	0.50	0.16	1.76
	(0.62)	(0.17)	(0.90)
MAC	-0.12	-0.24**	0.44*
	(-1.30)	(-2.34)	(1.78)
TA	-0.33	-0.46	0.24
	(-0.82)	(-1.01)	(0.25)
SIZE	-0.00	0.00	-0.00
	(-0.10)	(0.05)	(-0.35)
RISK	-0.01	-0.01	-0.02
	(-0.76)	(-0.55)	(-0.50)
ORG	0.10***	0.09***	0.11**
	(6.17)	(5.71)	(2.03)
COOP	0.08***	0.08***	0.09
	(3.99)	(3.81)	(1.32)
SB	0.10***	0.09***	0.21***
	(4.18)	(3.28)	(2.77)
SI	-0.03	-0.03	-0.06
	(-1.62)	(-1.47)	(-0.95)
SS	0.10***	0.09***	0.09
	(5.31)	(4.99)	(1.46)
N. of firms	2,713	2,420	293
Censored (TURNIN = 0)	615	550	65
Uncensored	2,098	1,870	228

Notes
t- statistics in parentheses: * Significant at 10%; ** 5%; *** 1%

Table 5 presents the above specification extended to the entrepreneurial variables discussed in the previous sections. First of all, all the results deriving from Table 4 above are fully confirmed and so will not be commented on further. As can be seen, the variable RISK (although negative in sign, as expected) never turns out to be even barely significant in any of the three regressions; hence, it seems that risk aversion is not deterring Italian firms from being innovative[18].

Shifting our attention to the ability to engage in various forms of organizational change, it turns out to be positively and significantly related to firms' innovative capacity, as expected. However, in this case too, the link appears less significant in the case of the YICs.

Finally, cooperative agreements (COOP) in general turn out to affect product innovation positively and significantly; however, this relationship is not significant with regard to the YICs. This is a further disappointing result concerning the entrepreneurial profile of Italian YICs; indeed, either they lack the endogenous capabilities and 'absorptive capacities' to engage in effective innovative cooperation, or they are unable to create value (in terms of product innovation) from such cooperation.

As a further control, Table 6 reports the results from a restricted specification where the non-significant regressors have been dropped (ER, TA, SIZE, RISK); as can be noted, all the previous outcomes are fully confirmed.

[18] However, this may simply be due to possible inaccuracy in the adopted proxy, the only one available in our dataset.

Table 6 - *Restricted Specification*

	ALL FIRMS	**MATURE FIRMS**	**YOUNG FIRMS (YICs)**
Dependent variable: TURNIN			
Constant	0.12***	0.12***	0.12*
	(6.92)	(6.92)	(1.91)
IR	2.01***	2.05***	1.83***
	(7.52)	(7.09)	(2.62)
MAC	-0.12	-0.24**	0.47*
	(-1.33)	(-2.40)	(1.91)
ORG	0.10***	0.09***	0.10*
	(6.12)	(5.67)	(1.93)
COOP	0.08***	0.08***	0.10
	(4.10)	(3.89)	(1.51)
SB	0.10***	0.09***	0.21***
	(4.32)	(3.35)	(2.79)
SI	-0.03	-0.03	-0.06
	(-1.60)	(-1.46)	(-0.95)
SS	0.10***	0.09***	0.09
	(5.37)	(5.04)	(1.45)
N. of firms	2,713	2,420	293
Censored (TURNIN = 0)	615	550	65
Uncensored	2,098	1,870	228

Notes
t- statistics in parentheses: * Significant at 10%; ** 5%; *** 1%

On the whole, our econometric results show that in comparison with the incumbents, Italian YICs appear to be less R&D-based, more dependent on external sources of knowledge, slightly less inclined to carry out organizational change and lacking the ability to engage into fruitful innovative agreements.

5. Conclusions and policy implications

The focus of this paper is on the determinants of innovative output in both young and mature Italian firms, by looking at firms' internal and external R&D activities as well as at the acquisition of external technology in its embodied and disembodied components. Moreover, the possible roles of size, three proxies of entrepreneurial ability and sectoral belonging have been tested.

Overall, it turns out that in-house R&D is linked to innovative performance, while external sources of knowledge do not seem to play an important role in Italian manufacturing. However, when the sample is split in young and established firms, for the former internal R&D expenditures play a smaller role in increasing innovation intensity, while the external acquisition of technology in its embodied component achieves a certain significance.

Turning our attention to the sectoral distribution of Italian YICs, this does not significantly differ from that characterising the whole sample.

Finally, looking at the entrepreneurial proxies, two out of three turn out to play a significant role in positively affecting firms' innovative output; however, these effects are either weaker or even absent if attention is specifically focused on the YICs.

These results suggest that in the Italian intermediate-technology context, on average YICs cannot be considered as R&D-based NTBFs. On the contrary, they appear to be rather weak entrepreneurial entities which need to acquire external knowledge in order to foster their own innovation activity and which face significant difficulties in engaging into creative strategies, such as organizational change, and above all, cooperative innovation.

In terms of policy implications, these outcomes highlight a potential weakness of Italian YICs, which seem to lack a fully-fledged endogenous capacity to sustain their own innovative activities. In turn, this calls for an industrial and innovation policy able to foster pure NTBFs, that is a policy encouraging a more creative behaviour based on entrepreneurship and R&D-based innovation strategies.

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Appendix

Table A1 - *Correlation matrix*

	TURNIN	IR	ER	MAC	TA	SIZE	RISK	ORG	COOP
TURNIN	1.000								
IR	0.189	1.000							
ER	0.086	0.245	1.000						
MAC	-0.034	-0.070	-0.046	1.000					
TA	-0.010	0.026	0.044	0.034	1.000				
SIZE	0.034	0.052	0.054	-0.041	-0.008	1.000			
RISK	0.123	0.173	0.168	-0.074	0.014	0.020	1.000		
ORG	0.122	0.077	0.053	-0.086	0.031	0.095	0.090	1.000	
COOP	0.006	0.035	0.062	-0.026	0.000	0.209	0.065	0.121	1.000

Table A2 - *The questionnaire*

Innovative output variable: TURNIN	
Estimate how your turnover in 2000 was distributed between: - new or significantly improved products (goods or services) introduced during the period 1998-2000 - unchanged or only marginally modified products (goods or services) during the period 1998–2000	
Innovative input variables	
Did your enterprise engage in the following innovation activities in 2000?:	
IR: Intramural research & experimental development (R&D)	All creative work undertaken within your enterprise on a systematic basis in order to increase the stock of knowledge, and the use of this stock of knowledge to devise new applications, such as new and improved products (goods/ services) and processes (including software research)
ER: Acquisition of R&D (extramural R&D)	Same activities as above, but performed by other companies (including other enterprises within the group) or other public or private research organisations
MAC: Acquisition of machinery and equipment	Advanced machinery, computer hardware specifically purchased to implement new or significantly improved products (goods/services) and/or processes
TA: Acquisition of other external knowledge	Purchase of rights to use patents and non-patented inventions, licenses, know-how, trademarks, software and other types of knowledge from others for use in your enterprise's innovations
SIZE	▪ What was your enterprise's total number of employees in 1998 and 2000?
RISK	▪ During the period 1998-2000, how important were the following factors as constraints to your innovation activities or influencing a decision not to innovate? : - Excessive perceived economic risk
ORG	▪ Did your enterprise during the period 1998-2000 undertake any of the following activities?: -Strategy (Implementation of new or significantly changed corporate Strategies) -Management (Implementation of advanced management techniques within your enterprise) -Organisation (Implementation of new or significantly changed organizational structures)
COOP	▪ Did your enterprise have any co-operation arrangements on innovation activities with other enterprises or institutions during 1998-2000?

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