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*Assessing and measuring the equity gap and the equity requirements for innovative SMEs*

by Elisabetta Gualandri and Valeria Venturelli

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# Assessing and measuring the equity gap and the equity requirements for innovative SMEs

Elisabetta Gualandri and Valeria Venturelli

*This paper sets out to critically review the different approaches developed for the assessment and measurement of the equity gap for innovative firms, mainly SMEs, extending the quantitative approaches for equity gap developing a demand-side model that allows to predict the future demand for equity in precise terms. Through the application of an original model to a sample of Italian firms, we find that, the amount of equity needed, expressed in absolute terms, is on average tiny (147.3 K euro). Moreover, the size of the additional equity requirement is clearly influenced by the role of the current debt. The results of the cluster analysis confirms that the degree of innovation cannot be considered the main discriminating factor when it comes to the differences in equity requirement per unit of marginal sale; while the regression analysis reveals the pivotal role played by the enterprise's year of foundation.*

*Field of Research: Finance, Equity gap, Innovative SMEs*

*JEL classification: G24, M13, O16, O38, R58*

Elisabetta Gualandri, [gualandri.elisabetta@unimore.it](mailto:gualandri.elisabetta@unimore.it), University of Modena and Reggio Emilia and CEFIN – Centro Studi Banca e Finanza [www.cefin.unimore.it](http://www.cefin.unimore.it)  
Valeria Venturelli, [venturelli.valeria@unimore.it](mailto:venturelli.valeria@unimore.it), University of Modena and Reggio Emilia and CEFIN – Centro Studi Banca e Finanza [www.cefin.unimore.it](http://www.cefin.unimore.it)

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## Introduction

This paper sets out to investigate the problem of assessing and measuring the equity gap for innovative SMEs. It contributes to the current debate with the development of an original demand-side model that allows to predict the future demand for equity (so-called equity requirement) in precise terms. The results of the model can be considered a proxy of the equity gap.

The relevance of the topic stems from the fact that financing of innovation is a strategic target for policy makers, since innovation is generally considered one of the main drivers of economic growth, both in terms of its impact on the individual firm's performance and at the aggregate level, through innovation's effects on a country's competitiveness and thus, in the final analysis, on the economy's growth rate (European Commission, 2001a and 2002).

Various authors (Berger and Udell, 1998) have reported that, due to market failures, equity is the form of finance best suited to providing the entrepreneur with the additional resources needed for the development of the innovative project. In continental Europe, the relative backwardness of financial systems (Rajan and Zingales, 2001; European Commission, 1998 and 2003b), when it comes to providing financial backing to the most innovative firms, aggravates the structural difficulties faced by SMEs in obtaining access to finance, and in particular amplifies the problems related to the availability of equity. This problem is especially serious for start-ups and the smallest firms, for which venture capital is not generally the main means of boosting the level of capitalisation. This contributes to create a lack of resources available for equity investments, known as the equity gap.

During the last few years, the "question" of the existence and size of the equity gap has attracted a large number of researchers. However, there is still a great deal of uncertainty concerning the method to be used to produce a quantitative estimate of the size of the phenomenon.

In our paper we study the different approaches developed for the assessment and measurement of the equity gap, their limitations and level of significance. Our main finding is that demand-side analysis is the least well developed, especially as far as the quantitative approach is concerned, due to difficulties in data collection and in defining a suitable methodology. Although this method is currently the least used, it is the most interesting from the methodological point of view.

Our intention is to pursue this quantitative approach, with the main aim of measuring the future demand for equity on the part of firms, with a particular focus on firms in innovative sectors.

Through the application of a model to a sample of Italian firms located in the Emilia Romagna region, we find that, irrespective of the degree of innovation, the amount of equity needed, expressed in absolute terms, is on average tiny (147.3 K euro). Moreover, the size of the additional equity requirement is clearly influenced by the role of the current debt.

The regression analysis reveals that the enterprise's year of foundation, and thus its youth, appears to be the main discriminating factor when it comes to the difference in equity requirement for incremental unit of sales.

The results of the cluster analysis confirms that the degree of innovation cannot be considered the main discriminating factor when it comes to the differences in equity requirement per unit of marginal sale; nonetheless, an analysis of the equity requirement expressed in monetary terms reveals that innovative firms in the cluster characterised by the higher growth of rate in sales show the highest average value (645.9 thousand euro).

These amounts cannot be considered explicit evidence of an equity gap problem; nonetheless, they could point to its existence, since the figures are in line with the findings emerging from international studies centred on the financing obstacles to SMEs' growth.

The paper consists of 3 sections. The first surveys the theoretical literature on the financial constraints limiting SMEs' growth, with a special focus on the financial sustainability of the growth of innovative new enterprises. The second part of the paper surveys the main methods used and the thresholds identified in international studies on the equity gap. In the third part, using quantitative analysis, we study firms in Italy's Emilia Romagna region to identify the causes which generate financial needs to be covered by equity, and estimate the absolute and relative size of the investment required. Finally, the main conclusions of the study are presented.

## **1. Access to finance for innovative firms**

Traditionally (Bank of England, 2001), the process which leads from the birth of an innovative idea to the sale of the relative product on an industrial scale consists of four main stages, which differ substantially in their relative levels of financial needs. In the first stage (seed), where the innovative idea is conceived, there is a great deal of uncertainty concerning the potential results, and the financial needs often consist only of the expenditure required to make a technical and economic assessment of the investment plan. In this stage, the volume of sales is equal to zero, as is the capital intensity. In the second stage (start-up), the idea is presented to the market. In this stage, there is the need for large amounts of finance, countered initially by a substantial absence of revenues, associated with a rising capital intensity. In the following phase (early growth), the level of operating risk gradually decreases, while financial requirements continue to be high, as well as the degree of capital intensity combined with a rapid growth in working capital. In this stage, the high rates of growth in sales<sup>1</sup>, allow an increase in the rate of self-financing, although not sufficient to cover all financial needs. As the firm moves on to the sustained growth stage, the level of operating risk is lower, and the company increases its ability to generate internal resources, thanks to the high rate of growth in sales associated with a tendency for a reduction in capital intensity.

One of the specific features of innovative new firms is a growth process which is hard to sustain in financial terms. In particular, innovative firms therefore have characteristics which make it particularly difficult for them to finance themselves using debt capital<sup>2</sup>; the high operational and financial risks, the lack of a track record, their inability to offer guarantees, and the significant degree of moral hazard, all mean that, once we have accepted that capital markets are not perfect, innovative firms require different forms of finance to fund their innovation in the different stages of their life -cycles. According to the financial growth cycle (Berger and Udell, 1998) when an innovative idea is conceived the financial constraints are very tight, driving the entrepreneur to use informal sources of capital (his own and/or his relatives' savings, or equity provided by business angels). In the stages immediately after this, the problem of the impossibility of observing the

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<sup>1</sup> Petrella G., 2001, page 8 "In this stage the rate of growth of sales is, on average, high (30-40%)"

<sup>2</sup> For a survey, see Canovi L., Grasso A. G., Venturelli V., 2007

entrepreneur's actions in order to verify compliance with loan contract terms is particularly acute, and equity becomes necessary. In other words, the lack of track records and the fact that specific information about the project to be financed is hard to provide limits the availability of debt capital, or renders it prohibitively expensive. Once the critical start-up and growth stages have passed and firms have achieved stability, they tend to diversify their sources of finance, since the information asymmetries become less acute and enterprises have established reputations which enable them to operate on the financial markets.

As a consequence, the role played by venture capital operators during the initial stages of the firm's growth cycle is crucial, in providing expertise in a series of areas, as well as financial resources, during the stages where the risk of failure is high. However, some features of venture capital mean that it is not suitable for financing any kind of project; for example, it cannot be of assistance to investment schemes still in the embryonic (seed) stage, or on an economic scale too small for financiers to see the prospect of recovering their contract and evaluation costs. This problem, known as the small ticket problem (Berger and Udell, 1998 and Petrella, 2001), can be overcome through the involvement of business angels, who are willing to invest smaller amounts in projects still in the seed stage.

However, situations may arise in which the financial requirement is too small to be economically viable for venture capital operators, but too large for business angels to cover; this is the situation known as the equity gap<sup>3</sup>, in which there is a shortage of equity investment during the initial stages of the firm's life-cycle. The term equity gap, as the broader concept of financing gap, describes a situation in which, due to market failures, deserving companies do not receive the volume of financing to which they would be entitled in an efficient market (European Commission, 2005, p.7). It must be made clear that this concept does not merely refer to situations in which the demand and supply of capital fail to come together, as generally understood, without making a distinction between the actual gap and the perceived gap. Basically, the mere fact that some SMEs do not obtain capital does not in itself mean that there is a financial gap, unless we assume that the firms concerned are operating on a competitive, efficient market, in which some firms would in any case fail to obtain finance, because their risk profiles exceed those accepted by financial intermediaries for the expected return involved (OECD 2004 and 2006a)<sup>4</sup>. This definition already points to the difficulties intrinsic in the various attempts to measure the equity gap, which will be discussed in greater detail below.

## **2. Measuring the equity gap**

The subject of the equity gap and its measurement are attracting more and more interest from both academics and practitioners. A survey of the empirical literature reveals various lines of investigation which set out to measure the equity gap, apparently not an easy task.

Since an equity gap was first identified in the United Kingdom by the Macmillan Report in 1931, there have been numerous studies at the various national levels, especially in recent years, aiming to ascertain whether such a gap exists and trace its outlines, in terms of amount thresholds, any geographical/regional dimensions, and the types/sectors of firms and stages in the life-cycle affected.

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<sup>3</sup> For more details of the concept of the equity gap in the broader context of the financing gap, see Gualandri E., Schwizer P., 2007

<sup>4</sup> See OECD 2004, p. 14; for an in-depth technical discussion of the concept of the financing gap, see: OECD 2006a p.18

Three approaches can be identified in the main contributions to the debate<sup>5</sup>.

A first type of survey identifies the characteristics of the equity gap in a specific national context by monitoring the distribution of private equity investments by amount and by firm life-cycle stage, and analysing the trend in equity investments in the start-up and early/sustained growth stages over time, before making an international comparison, generally using the ratio of these investments to GDP<sup>6</sup>.

A second survey method makes a qualitative analysis by means of interviews/questionnaires targeting experts on the supply side who provide equity to SMEs (informal investors/business angels, venture capital and private equity professionals, banks and government agencies)<sup>7</sup>. The findings of this type of study tend to be affected by the composition of the panel/sample, which may fatally influence replies, as well as by anecdotal convictions<sup>8</sup>. It is also particularly difficult to monitor informal investors and business angels<sup>9</sup>. With regard to the evidence of a demand-side equity gap, surveys have been performed by conducting interviews and organising panel discussions with entrepreneurs, but here there are even greater problems deriving from the panel composition criteria and the resulting degree of representativeness. Nonetheless, interesting features arise from these surveys. Firstly, although not absolutely conclusive, there are findings which tend to link the equity gap to the type of financial system, and the presence of private equity and venture capital operators, as well as business angels. Secondly, the size of the equity gap in a given context appears to vary over time, probably due to differences in the survey procedures, the point in the economic cycle, and the evolution of the financial industry. For example, the evidence is that as the venture capital industry develops, the upper limit of the equity gap tends to rise, since after the business start-up stage operators tend to move towards deals involving larger amounts<sup>10</sup>.

One third procedure, the least widely used at present but definitely the most interesting in methodology terms, concerns a quantitative approach, using empirical analyses of demand-side data sets<sup>11</sup>. In our knowledge, the only study partially centred on this approach is the one developed by Harding and Cowling (2006). The investigation is based on both a qualitative analyses, with semi-structured interviews with experts in the sector, and an estimate of the demand-side equity gap starting from the 2003 GEM (Global Entrepreneurship Monitor) survey.

In terms of thresholds identified, the scenario studied in greatest depth is that of the United Kingdom, where a number of surveys in the early years of this century identified equity gaps for SMEs of between £250,000 and £1.5 million<sup>12</sup>. One of the latest study (Harding and Cowling, 2006) gives evidence of an equity gap of between £ 150,000 and £ 250,000 at the lower end and between £ 1.5 and £ 2 million at the upper end. More specifically, a further gap for small amounts, between £ 10,000 and £ 30,000, was identified in the expansion stage for firms between 18 and 24 months old, arising because of the need to meet regulatory and fiscal expenses.

The European Commission also indirectly identifies intervals which are proxies for the equity gap. The authorisation for measures to assist in the provision of equity requires

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<sup>5</sup> See H. M. Treasury-SBS, 2003a; Harding R., 2002; Harding R., Cowling M., 2006; European Commission 2005, OECD 2006a

<sup>6</sup> See H. M. Treasury-SBS, OECD 2006a

<sup>7</sup> See Harding R.2002; Harding R., Cowling M. 2006, H. M: Treasury-SBS 2003a and 2003b, OECD 2006a

<sup>8</sup> See Harding and Cowling, 2006

<sup>9</sup> See H. M. Treasury-SBS, 2003a and 2003b, Lawton T. C. 2002, p.16

<sup>10</sup> See H. M. Treasury-SBS 2003b, p. 24

<sup>11</sup> Harding R., Cowling M. 2006

<sup>12</sup> See Harding R. 2002; Mason C. M., Harrison R. T., 2003; H. M. Treasury, Small Business Service, 2003

proof of market failures identified a priori as thresholds varying in amount depending on the type of area involved, less than 500,000 euro, 750,000 euro or one million euro as the case may be (European Commission, 2001b). Maximum level of investment tranches of 1.5 million euro per target SME over each period of twelve months was set in July 2006<sup>13</sup>.

Basically, the study and measurement of the equity gap is conducted along a number of main lines<sup>14</sup> mostly focusing on the supply side. Alongside these is a third procedure, which offers a quantitative approach, using empirical analyses of demand-side data sets. Adopting this approach, our next section will provide an in-depth analysis of a quantitative model developed in order to estimate the capital requirement, identifying the causes which generate it and comparing the findings with the thresholds reported in the main international surveys.

### 3. Equity requirement estimation model

A firm's growth, measured by means of the rise in its turnover within a specific period, generates an increasing need for financing which will be covered partly by self-financing and current debts, and partly from external sources, consisting of equity and loan capital. The models (Canovi, Grasso and Venturelli, 2007) generally adopted in empirical studies which aim to estimate the need for additional equity differ in terms of the hypothesis adopted with regard to the role of financial indebtedness in covering additional financial needs. Here, the model for estimating the equity requirement is based on the hypothesis that financial indebtedness may grow provided the constraint of maintaining a constant ratio between financial debt and equity.

The equity requirement at constant leverage ( $FE_{LC}$ ) is estimated as the amount outstanding after deduction of the amounts covered by the other forms of finance envisaged by the model. It is assumed that the additional financial requirement generated by the growth in sales (FA) may be covered by self-financing (CA), an increase in current indebtedness (CDC) and the growth in financial indebtedness, provided the leverage (financial debt/equity) remains stable. Moreover, assuming that no significant changes in capital intensity, the margin of self-financing or the current indebtedness as a proportion of sales are expected, the following equations apply:

$$FA = X \cdot V_{t-1} \cdot K \quad (1)$$

X = Expected rate of growth in sales

$V_{t-1}$  = Sales for the period previous to the one being analysed

K = Total assets/Sales = Capital intensity

$$CDC = X \cdot V_{t-1} \cdot D_c \quad (2)$$

$D_c$  = Current debts/Sales

$$CA = X \cdot V_{t-1} \cdot A \quad (3)$$

A = Self-financing<sup>15</sup>/Sales

<sup>13</sup> European Commission, 2001; Official Journal C 194, 18.08.2006

<sup>14</sup> For a specific, detailed analysis of the methods and thresholds found in equity gap measurement studies at the international level, see Gualandri E., Schwizer P., 2007

<sup>15</sup> Self-financing = Net revenue + Amortisations – Profits distributed

In order to measure the amount covered by new financial debts, two values have to be obtained. The first ( $CDF_1$ ) derives from the fact that, since self-financing produces an increase in the firm's equity capital, financial debts increase by an amount equal to self-financing multiplied by leverage, without any change in the latter. Analytically:

$$CDF_1 = \frac{D_f}{E} \cdot X \cdot V_{t-1} \cdot A \quad (4)$$

If the additional financing required exceeds the sources analysed so far (self-financing, current debts, first component of financial indebtedness), there is a shortfall (DIF) equal to:

$$DIF = X \cdot V_{t-1} \cdot \left[ K - D_c - A \cdot \left( 1 + \frac{D_f}{E} \right) \right]$$

However, the whole of this shortfall cannot be financed by means of equity, since in this case the leverage ratio would fall. The part covered by additional new debts – in compliance with the constant leverage constraint - provides the second component of the growth in financial indebtedness ( $CDF_2$ ) and is equal to:

$$CDF_2 = X \cdot V_{t-1} \cdot \left[ K - D_c - A \cdot \left( 1 + \frac{D_f}{E} \right) \right] \cdot \frac{\frac{D_f}{E}}{1 + \frac{D_f}{E}} \quad (5)$$

The total cover provided by financial indebtedness (CDF) is therefore the sum of (4) + (5); this equation can be reduced to:

$$CDF = \frac{X \cdot V_{t-1} \cdot \frac{D_f}{E} \cdot (K - D_c)}{1 + \frac{D_f}{E}} \quad (6)$$

Finally, the equity requirement at constant leverage ( $FE_{LC}$ ) is obtained from subtracting all the forms of coverage examined so far from the additional financing requirement. More simply, the equity requirement at constant leverage is the same as the fraction  $[1/(1+D_f/E)]$  of the financial shortfall:

$$FE_{LC} = X \cdot V_{t-1} \cdot \left[ K - D_c - A \cdot \left( 1 + \frac{D_f}{E} \right) \right] \cdot \frac{1}{1 + \frac{D_f}{E}} \quad (7)$$

### 3.1. Description of the sample

The sample studied is the result of an extraction from the AIDA Database which contains economic and financial information about limited companies operating in Italy with sales in excess of 500,000 euro. The extraction was limited to companies having registered office in the Emilia Romagna region, operating in the manufacturing sector and in the service sector. The model is tested on SMEs located in Emilia Romagna region since these firms can be considered an adequate proxy of an "average" Italian SMEs; moreover the financial supply in this region is similar to the one in the rest of the country.

The analysis was conducted only on share capital companies<sup>16</sup> in a growth stage<sup>17</sup> with financial statement data available in the period 2003-2005. A number of methodological decisions were then taken in order to obtain a sample in line with the purposes of the study. First of all, the analysis was restricted to SMEs only, meaning that large firms (i.e. those with 2005 sales in excess of 50 million euro) were excluded from the sample<sup>18</sup>. Moreover, constraints were set with reference to the size of the current debt/sales ratio (less than 100% in terms of annual average during 2003/2005) and the leverage ratio  $D_t/E$  (positive, but less than 10 in the same period).

The application of these selection criteria enabled us to identify a sample of 4508 firms, 5/6 of which belonged to the micro- and small-enterprise size categories. In terms of sectorial distribution, firms in the manufacturing sector predominated (78.2%), while with regard to the degree of innovation, overall almost 14% of the sample studied consisted of high-tech firms with medium and high technology content<sup>19</sup>. With regard to the geographical distribution across the region's provinces, one quarter of firms were located in one of the municipalities of the province of Bologna followed, in order of importance, by firms in the provinces of Modena (22.5%), Reggio Emilia (15.4%) and Parma (10.4%).

### 3.2. The equity requirement of SMEs in the Emilia Romagna region

Application of the Model allows identification of the causes which generate financial needs to be covered by equity, and estimation of the absolute and relative size of the investment required. In general, the average growth rate in sales of the firms in the sample is 13.8% (Tab. 1). Therefore, these firms enjoy medium-high average growth rates, which are taken up and used in the model for estimating the equity requirement.

**Tab. 1 – Model Inputs** (annual average per firm 2003-2005)

	Mean	Median	Standard Dev .	Minimum	Maximum
Number	4508				
X - Rate of growth in sales (%)	13.8	9.8	13.7	0.0	98.6
A - Self-financing margin (%)	5.5	4.2	5.4	- 44.2	45.4
K - Capital intensity	0.79	0.74	0.30	0.10	3.63
$D_c$ - Current debts/Sales (%)	44.0	39.8	19.1	5.2	100.0
$D_t/E$ - Financial debts/Equity	0.76	0.00	1.66	0.00	5.2

Source: processing of AIDA Database data

The average annual self-financing margin for the three-year period is 5.5%. This figure conceals a high degree of variation in the values, with a range running from– 44.2%

<sup>16</sup> All companies not registered as limited liability companies, single-shareholder limited liability companies and joint-stock companies were excluded

<sup>17</sup> This implied the exclusion from the sample only of companies with negative growth in sales, while also requiring an average annual rate of growth in sales for the period of reference(2003-2005) not exceeding 100%

<sup>18</sup> See European Commission Recommendation of 6 May 2003, OJ L 124, 20/05/2003. In detail, companies with sales below the 2 million Euro threshold are defined as micro-enterprises and those between 2 and 10 million Euro as small enterprises, while medium-sized enterprises are defined as those having sales volumes between 10 and 50 million Euro

<sup>19</sup> See Cavallo C., Lazzeroni M., Patrono A., Piccaluga A., 2002. In the intermediate industry and services census, a distinction is made between the high-tech sector with high technology content, the high-tech manufacturing sector with medium technology content, high-tech service sectors with high technology content and high-tech service sectors with medium technology content

to + 45.4% (Tab. 1). However, overall the self-financing margins are not particularly high, and thus the resources generated by the company's own operations cannot be the main means of providing the financing needed. It should also be borne in mind that the self-financing margin was calculated without taking into consideration any distribution of profits. Although not particularly important for firms of this kind, this hypothesis should still be considered, because the distribution of profits would imply even lower self-financing margins than those recorded here.

The capital intensity value does not lead to the identification of any "capital intensive" firms, in line with the production organisation typical of the Emilia Romagna region.

The role of current debt is particularly important when this value is measured by means of an indicator which links it to sales: on average, operating debt provides financial coverage for 44% of sales. This source of financing, already highly significant for the sample on average, is especially significant for micro and small enterprises less than five years old; therefore, as a company's size and age increase, the extent of its use of current debt decreases.

The last parameter considered, leverage, is fairly low (0.76), although the range is wide, as the high standard deviation indicates. In relative terms, the lowest indebtedness ratio is found in young firms and micro-enterprises. Overall, the sample group seem not to make particularly aggressive use of leverage; therefore, the firms studied should not find it too difficult to increase their level of financial indebtedness, especially within the limit needed to keep their leverage constant, as envisaged by the model.

Assuming a constant indebtedness ratio, the additional need for financing generated by the growth in sales is covered (Tab. 2), on average, by self financing (7.1%), by increasing current debts (59.5%), by new financial indebtedness (10.7%) and for the remainder (22.8%) by equity.

**Tab. 2 – Application of the  $FE_{LC}$  Model** (average per firm)

	Mean	Median	Standard Dev.	Min	Max
CA/FA - Self-financing/Additional financing requirement (%)	7.1	5.8	6.4	-52.1	60.1
CDC/FA - Current Debt/Additional financing requirement (%)	59.5	60.2	22.5	6.8	131.5
CDF/FA - Financial debt requirement/Additional financing requirement (%)	10.7	0.0	17.3	0.0	74.7
$FE_{LC}$ /FA - Equity requirement/Additional financing requirement (%)	22.8	18.8	17.6	-28.2	87.2
CDF/ $XV_{t-1}$ - Financial debt requirement/Expected variation in sales (%)	9.9	0.0	19.4	0.0	246.9
$FE_{LC}$ / $XV_{t-1}$ - Equity requirement/Expected variation in sales (%)	19.1	13.3	19.3	-13.4	140.3
$FE_{LC}$ - Equity requirement (000 Euros)	147.3	34.5	403.8	-207.5	9031.7

Source: processing of AIDA Database data

The results once again confirm the essential role of current debt. It should be underlined that this form of cover is often ignored, with a few exceptions (Biais and Gollier, 1997), in theoretical studies, because operating debt is a source of financing intrinsic to growth, and is thus not picked up by analyses which focus on the relationship between equity and financial debt.

After highlighting the importance of current debt, a closer analysis must be made of the equity requirement. When we look at the ratio between equity capital requirement and expected sales (on average 19.1%) we find a direct relationship with the enterprise's size and age (Tab. 3). In particular, an examination of the size class indicates a positive relationship between increase in firm size and use of financial indebtedness. Specifically, financial debts cover 4.2% of the increase in sales for micro-enterprises and 25.9% for medium-sized firms. Alongside these values, there is an equity requirement per unit of marginal sales which follows the same trend, rising from 17.6% for the smallest size category to 21.8% for the medium-sized enterprise class. The results of the financial indebtedness are coherent with the size of the leverage – smaller for micro-enterprises (0.4) and higher for medium-sized firms (1.7) – on the one hand, while those related to the equity requirement are consistent with the current debt ratio, higher for micro-enterprises (47.2%) and lower for medium-sized firms (33.7%). Concerning the age, the direct relationship with additional equity requirement for unit of marginal sale is consistent with the degree of coverage offered by current debt; higher for younger enterprises (49.8%) than for more consolidated ones (40.7% for firms established by more than 10 years).

Moreover, manufacturing firms have a higher equity requirement than service firms; while the degree of innovation does not provide a statistical significant basis for a distinction between firms with different equity requirements.

**Tab. 3 – The segmentation of the significant variables** (average per firm)

	CA/FA - Self- financing/Ad- ditional financing requirement (%)	CDC/FA - Current Debt/Additio- nal financing requirement (%)	CDF/FA - Total financial debt requirement/ Additional financing requirement (%)	FELc/FA - Equity requirement/ Additional financing requirement (%)	CDF/XV t-1 - Financial debt requirement/ Expected variation in sales (%)	FELc/XV t-1 - Equity requirement/Ex- pected variation in sales (%)	FELc - Equity requirement (000 Euros)
<b>Size</b>							
Micro	7.3	65.6***	4.7***	22.4	4.2***	17.6***	28.0***
Small	7.0	60.7***	9.6***	22.7	8.7***	19.3	109.0***
Medium-sized	7.0	42.5***	26.7***	23.7	25.9***	21.8***	521.2***
<b>Age of firm</b>							
≤ 5 years	6.6	71.8***	6.8***	14.8***	6.2***	11.3***	128.8
Between 5 and 10 years	7.2	64.8***	8.4***	19.7***	7.4***	15.8***	106.5***
> 10 years	7.1	52.4***	13.4***	27.0***	12.8***	23.6***	185.6***
<b>Degree of innovation</b>							
High-Tech	7.8***	56.9***	10.6	24.7***	9.9	20.1	165.1
Non High-Tech	7.0	59.9	10.7	22.5	9.9	19.0	144.5
<b>Business sector</b>							
Manufacturing	6.9*	58.3***	11.8***	22.9	11.2***	19.8***	157.3
Services	7.6**	63.8***	6.4***	22.2	5.4***	16.7***	111.4***

Source: processing of AIDA Database data

The Test T was calculated for every single group in relation to the overall average of the sample.  $H_0$ : Average = sample overall average. Statistical significance at the level of 10%, 5% and 1% indicated respectively by symbols \*, \*\*, and \*\*\*

With regard to the equity requirement expressed in monetary terms, the aggregate value of 147.3 thousand euros for the entire sample conceals a high degree of variation: the range is from a value of 28.0 thousand euros for micro-enterprises to 521.2 thousand

euros for medium-sized firms, confirming that the equity requirement is correlated to business size, as expected.

To conclude, the groups identified present additional equity requirement statistically different in relation both to size and age; on the other hand, no significant differences were found with the firm's degree of innovation.

The size and significance of the differences within the groups identified can be investigated by analysing the variance. Tab. 4 leads to the conclusion that the groups identified are statistically different; the significance of the differences between groups indicates that the groups are heterogeneous both with regard to the size variable and in relation to the enterprise's year of establishment.

**Tab. 4 – ANOVA**

			Difference between means	Std. Error	Sig
Size	Micro	Small	-.0176283(*)	.0063513	.006
		Medium	-.0426110(*)	.0086013	.000
	Small	Micro	.0176283(*)	.0063513	.006
		Medium	-.0249827(*)	.0082312	.002
	Medium	Micro	.0426110(*)	.0086013	.000
		Small	.0249827(*)	.0082312	.002
Age	Up to 5 y	Between 5 and 10	-.0448902(*)	.0097559	.000
		Over 10	-.1232146(*)	.0095987	.000
	Between 5 and 10	Up to 5 y	.0448902(*)	.0097559	.000
		Over 10	-.0783243(*)	.0059309	.000
	Over 10	Up to 5 y	.1232146(*)	.0095987	.000
		Between 5 and 10	.0783243(*)	.0059309	.000

Source: processing of AIDA Database data

To test if the groups identified present significant interactions, it is possible to analyse the variance at two classifications criteria. The univariate general linear model provides the basis for a variance analysis for the equity requirement per unit of incremental sales, through the factor variables (size – G\_D and age of firm – G\_E) which subdivide the population into significantly different groups. In particular, this procedure makes it possible to analyse the interactions between factors, and the effects of individual factors on the variance of the dependent variable.

**Tab. 5 Test on effects between subjects - Dependent variable Equity requirement/Expected growth in sales**

Source	Sum of squares	df	Mean of squares	F	Sig
Corrected model	9.822(a)	8	1.228	34.844	0.000
Intercept	57.109	1	57.109	1,620.780	0.000
G_D	0.372	2	0.186	5.280	0.005
G_E	5.358	2	2.679	76.033	0.000
G_D * G_E	0.365	4	0.091	2.588	0.035
Error	158.524	4,499	0.035		
Total	333.217	4,508			
Adjusted total	168.346	4,507			

a. R squared = .058 (adjusted R squared= .057)

Source processing of AIDA Database data

Table 5 allows us to conclude that the individual factors relating to enterprises' age and year of foundation are statistically significant, and the existence of significant interactions between the factor variables suggests that there's a "structure" in the differences between means that varies in relation to the level of the factors. To verify this structure, it is possible to develop a plot analysis or a simple linear regression model. The results of the latter are presented here (Tab. 6). The aim of this analysis is not to assess the model's degree of fit, but to evaluate the significance of the differences in the subgroups identified by the combination between the firm's size (d) and its age (e). Analytically:

$$y_{ij} = \sum_{i=1}^3 \sum_{j=1}^3 d_i e_j + e_{ij}$$

**Tab. 6 Regression results - Dependent variable Equity requirement/Expected growth in sales**

	Non-standardised coefficients		Standardised coefficients	t	Sig
	B	Std. Error	Beta		
(Constant)	0.096	0.012		7.811	0.000
DE12	0.065	0.014	0.128	4.661	0.000
DE13	0.132	0.015	0.228	9.074	0.000
DE21	0.020	0.018	0.020	1.066	0.286
DE22	0.054	0.014	0.110	3.910	0.000
DE23	0.142	0.013	0.320	10.557	0.000
DE31	0.093	0.031	0.047	3.015	0.003
DE32	0.079	0.018	0.084	4.367	0.000
DE33	0.143	0.015	0.230	9.558	0.000

R squared = .058 (adjusted R squared= .057)

Source: processing of AIDA Database data

The representative variables of the groups identified are dummy variables and thus it becomes necessary to find a marginal class to be used as benchmark for the analysis. This class was selected from the combination of micro-enterprises (D1) founded less than 5 years earlier (E1).

In general terms, the most consolidated enterprises are those which show the most noticeable, and significant, differences from the class of young micro-enterprises with regard to additional equity requirement per unit of incremental sales. In fact, the regressors enable us to conclude that the equity requirement per unit of sales is directly proportional to the age of the firm; this finding is confirmed by the simple descriptive analysis (Tab. 7). For firms of the same age, it is not possible to trace systematic relationships with the enterprises' size category since it varies in relation to each age group identified. So, we can therefore conclude that it is the age of the enterprise and not the size category which is the decisive factor in determining the differences in equity requirement per unit of marginal sales. In particular, the third class, that's to say the class with "older" enterprises show the largest differences in terms of equity needed respect young micro firms; moreover the equity requirements for older enterprises only slightly increase with the size of the firm.

**Tab. 7 Descriptive statistics by subgroup****Dependent variable: Equity requirement per unit of incremental sales**

		Interactions	Number	Mean	Std Dev.
Micro	≤ 5 years	DE11	233	9.6	11.8
	Between 5 and 10 years	DE12	792	16.1	16.9
	Over 10 years	DE13	571	22.8	20.6
Small	≤ 5 years	DE21	187	11.6	14.8
	Between 5 and 10 years	DE22	854	15.0	16.9
	Over 10 years	DE23	1,138	23.9	20.9
Medium	≤ 5 years	DE31	44	18.9	18.1
	Between 5 and 10 years	DE32	201	17.5	18.8
	Over 10 years	DE33	488	23.9	21.2

Source: processing of AIDA Database data

A further level of investigation was added in order to ascertain whether there are differences in the behaviour of innovative firms<sup>20</sup>. The 4508 firms were divided into subgroups on the basis of two significant parameters – the average growth rate in sales over the two-years period and the additional equity requirement per unit of marginal sale – following the cluster analysis' techniques. To identify the homogeneous groups of elements; we chose to apply the hierarchical clustering procedure using the Ward method, which combines clusters in such a way that, at each clustering pass, the two clusters which merge are those with the smallest increase in the total sum of the squares of the distances within the cluster itself.

Our analysis identifies 10 clusters which group together companies with similar conditions with regard to profiles linked to growth in sales and additional equity requirement per unit of marginal sale (Tab. 8).

**Tab. 8 - Clusters identified**

	Frequency	Valid percentage	Cumulative percentage
Cluster 1	404	9.0	9.0
Cluster 2	622	13.8	22.8
Cluster 3	486	10.8	33.5
Cluster 4	1,136	25.2	58.7
Cluster 5	678	15.0	73.8
Cluster 6	305	6.8	80.5
Cluster 7	121	2.7	83.2
Cluster 8	492	10.9	94.1
Cluster 9	181	4.0	98.2
Cluster 10	83	1.8	100.0
Total	4,508	100.0	

Source: processing of AIDA Database data

<sup>20</sup> We are considering a universe affected by the cover provided by the initial database, and not samples extracted at random. Therefore it is not possible to use methods of analysis based on statistical inference procedures; more information can be obtained with the aid of analysis based on descriptive statistical techniques

**Tab. 9 - Univariate ANOVA**

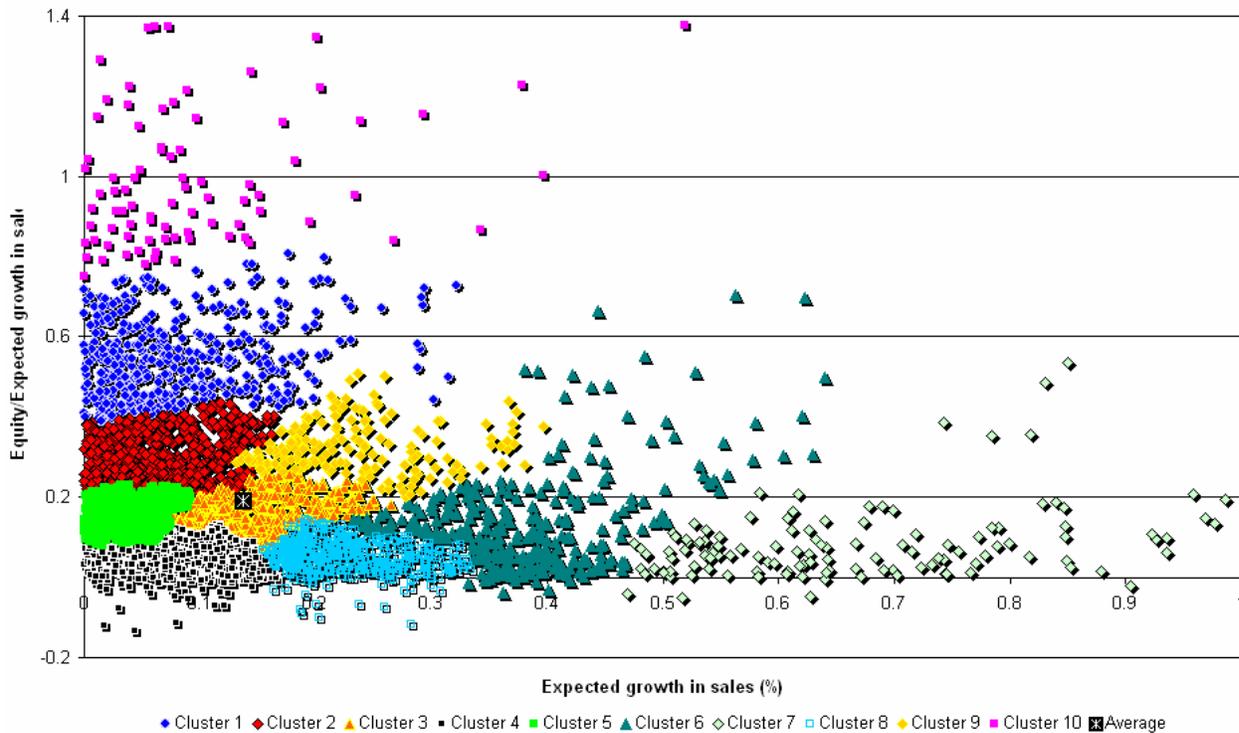
		Sum of squares	df	Mean of squares	F	Sig
X - Rate of growth in sales	Between groups	71.755	9	7.973	2908.79	.000
	With groups	12.329	4498	0.003		
	Total	84.084	4507			
FE <sub>L</sub> C/XV <sub>L-1</sub> - Equity requ. /Exp. growth in sales	Between groups	150.316	9	16.702	4166.63	.000
	With groups	18.030	4498	0.004		
	Total	168.346	4507			

Source: processing of AIDA Database data

Table 9 reveals the characteristics of the individual clusters which are statistically different, and thus identifies homogeneous groups of enterprises. The Post-Hoc test<sup>21</sup> allows the differences to be identified in detail by comparing pairs of clusters. With a few exceptions, the significance values confirm the diversity of the groups.

When plotted as a graph, the spread of the clusters over the diagram Rate of growth in sales – Equity requirement/Expected variation in sales - shows the configuration illustrated in figure 1.

**Fig. 1 Spread of clusters**



Source: processing of AIDA Database data

Table 10 allows us to infer a number of stylised facts on the basis of the uniform subsets revealed by the cluster analysis. Unless otherwise stated, the values in table 10 refer to the mean value of the variables observed.

<sup>21</sup> The information is available from the authors on request

**Tab. 10 – Clusters and firms' degree of innovation** (average per firm)

Cluster.	1	2	3	4	5	6	7	8	9	10	Total
<i>High-Tech</i>											
Number of firms	52	93	79	119	98	47	25	65	27	10	615
X - Growth in sales (%)	7.9	7.3	15.0	7.5	3.9	38.7	66.8	22.6	23.5	8.5	15.0
FE <sub>L,C</sub> /XV <sub>t,t-1</sub> - Equity requ./Exp. growth in sales (%)	54.0	30.1	17.2	5.7	15.8	15.2	10.9	5.1	31.2	99.5	20.1
CDF/XV <sub>t,t-1</sub> - Debt requ./Exp. growth in sales (%)	9.2	7.0	9.5	12.5	8.1	17.6	6.6	10.3	8.9	1.9	9.9
D <sub>c</sub> - Current debts/Sales (%)	29.9	38.3	42.5	45.4	41.6	52.8	58.1	44.9	37.9	32.9	42.5
A - Self-financing/Sales (%)	9.7	8.1	5.7	4.1	4.6	6.3	4.4	4.4	6.8	15.1	6.0
K - Capital intensity	1.03	0.84	0.75	0.68	0.70	0.92	0.80	0.65	0.85	1.49	0.78
D <sub>i</sub> /E – Financial debts/Equity	0.15	0.17	0.46	1.54	0.46	0.88	0.73	1.22	0.26	0.02	0.71
FE <sub>L,C</sub> - Equity requirement/ (000 Euros)	230.7	130.7	164.0	26.0	36.4	376.3	645.8	66.4	582.4	389.4	165.1
<i>Non High-tech</i>											
Number of firms	352	529	407	1017	580	258	96	427	154	73	3893
X - Growth in sales (%)	8.0	6.6	14.6	7.9	4.2	38.1	66.1	22.5	23.1	9.8	13.6
FE <sub>L,C</sub> /XV <sub>t,t-1</sub> - Equity req./Exp. growth in sales (%)	54.0	30.4	16.1	4.6	15.2	13.3	7.7	5.3	32.5	99.4	19.0
CDF/XV <sub>t,t-1</sub> - Debt req./Exp. growth in sales (%)	8.0	11.1	10.8	9.7	10.2	9.6	9.6	8.8	11.1	12.8	9.9
D <sub>c</sub> - Current debts/Sales (%)	35.7	38.6	45.5	47.0	42.7	48.8	53.2	49.5	43.0	35.5	44.2
A - Self-financing/Sales (%)	9.2	6.7	5.1	4.0	4.9	4.5	4.3	4.1	7.2	12.0	5.4
K - Capital intensity	1.07	0.87	0.77	0.65	0.73	0.76	0.75	0.68	0.94	1.60	0.79
D <sub>i</sub> /E – Financial debts/Equity	0.14	0.33	0.55	1.34	0.55	0.70	1.27	1.18	0.30	0.12	0.77
FE <sub>L,C</sub> - Equity requirement/ (000 Euros)	301.1	154.1	165.5	18.7	36.5	371.5	336.7	67.7	453.3	558.3	144.5
<i>Total</i>											
Number of firms	404	622	486	1136	678	305	121	492	181	83	4508
X - Growth in sales (%)	8.0	6.7	14.7	7.9	4.1	38.2	66.3	22.5	23.2	9.7	13.8
FE <sub>L,C</sub> /XV <sub>t,t-1</sub> - Equity req./Exp. growth in sales (%)	54.0	30.4	16.2	4.7	15.3	13.6	8.4	5.3	32.3	99.4	19.1
CDF/XV <sub>t,t-1</sub> - Debt req./Exp. growth in sales (%)	8.2	10.5	10.6	10.0	9.9	10.8	8.9	9.0	10.8	11.5	9.9
D <sub>c</sub> - Current debts/Sales (%)	34.9	38.5	45.0	46.8	42.5	49.4	54.2	48.9	42.3	35.2	44.0
A - Self-financing/Sales (%)	9.2	6.9	5.2	4.0	4.8	4.8	4.4	4.2	7.2	12.4	5.5
K - Capital intensity	1.06	0.86	0.77	0.66	0.73	0.79	0.76	0.67	0.93	1.58	0.79
D <sub>i</sub> /E – Financial debts/Equity	0.14	0.31	0.54	1.36	0.53	0.73	1.16	1.19	0.29	0.11	0.76
FE <sub>L,C</sub> - Equity requirement/ (000 Euros)	292.0	150.6	165.3	19.4	36.5	372.3	400.6	67.5	472.6	538.0	147.3

Source: processing of AIDA Database data

Overall, with reference to both the rate of growth in sales and to the additional equity requirement, there are classes with specific distinguishing features on which the rest of our study will be focused.

The rate of growth in sales is particularly high for firms in cluster number 7, with an average growth rate for the two-year period considered of more than 66%; however, their additional equity requirement is low (8.4%) compared to the mean figure for the sample (19.1%). With regard to the ratio between additional equity requirement and expected growth in sales, the firms in cluster 10 combine a high equity requirement (average value over 99%) with a rate of growth in sales (9.7%) four percentage points below the average figure for the whole of the sample examined (13.8%).

On the other hand, no cluster featuring a high rate of growth in sales accompanied by a high additional equity requirement was found. The only cluster resembling this situation is cluster 9, where the rate of growth of sales (23.2%) and additional equity requirement (32.3%) are both above the average overall figures.

Moreover, Tab. 10 confirms some of the findings which emerged from the previous analysis; once again, although indirectly<sup>22</sup>, the role played by current debts in covering the additional financing requirement is clear. This finding clearly emerges for the firms in cluster 7; their low equity requirement, in spite of strong growth, is due mainly to the proportion of the additional financing needed covered by current debts, in view of a low self-financing margin (4.4%), which is below the average (5.5%). It is in this class that the ratio between current debts and sales reaches its highest level (54.2%) compared to an overall average for the sample more than 10 percentage points lower.

The same findings emerge from the analysis of the characteristics of the companies in cluster 10. Below-average growth is accompanied by a high equity requirement but also by the highest financial debt requirement (11.5%), although the capacity for self-financing is good (the self-financing margin is the highest amongst sample companies, at 12.4%). This additional need for financial resources is correlated on the one hand with the high capital intensity, which implies high financial needs even if the growth rate in sales is low, and on the other with a low level of coverage through the use of current debt.

With regard to the degree of innovation, in cluster 7 on average the firms in innovative sectors have a slightly higher rate of growth of sales, together with a higher equity requirement. Specifically, while the high-tech enterprises have a rate of growth of sales 0.77% above that of the other sectors, their gap in terms of additional equity requirement is more than 3 percentage points. It should also be underlined that the enterprises in cluster 7 (both high-tech and non high-tech) have similar capital intensity and sales growth rate values, and thus the two classes' additional financing requirement cannot be significantly different. The difference between them lies on the one hand in the difference in the degree of coverage provided by current debts (higher for the high-tech sector) and on the other in the potential for the use of financial debt, which is higher for the other sectors, and justified by the greater use of leverage. In terms of size, amongst the firms in cluster 7 the small enterprises, in innovative sectors, have the highest equity requirement (14.4%), while middle-sized high-tech firms have the highest rates of growth in sales (69.8%).

For cluster 10, the equity requirement is almost identical in the two classes (high-tech and non high-tech). This is the result of the compensation between phenomena acting in opposite directions: the lower growth rate and lower capital intensity of the high-tech sector, combined with a greater capacity for self-financing, produce a lower financial requirement. Thus, the fact that the equity requirement value is similar for the two types of firm is due to the lower level of coverage of the financial need provided by financial and operating debts for high-tech firms than for firms operating in traditional sectors. Once again, small firms in high-tech sectors have the highest additional equity requirement per unit of marginal sale (105.9%); it should also be noted that neither small firms nor micro-enterprises in innovative sectors belonging to cluster 10 include financial debt amongst the sources of financing used.

Considering the differences between high-tech and other sector for all the clusters identified, the additional equity requirement is quite similar between the two classes of enterprises. The degree of innovation, as previously underlined, cannot be considered the main discriminating factor when it comes to the differences in equity requirement per unit of marginal sale. Nonetheless, an analysis of the equity requirement expressed in monetary terms reveals that innovative firms in cluster 7 have the highest average value (645.9 thousand euro), followed by innovative enterprises in group 9 (582.4).

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<sup>22</sup> The table shows the incidence of current debts on sales. In actual fact, the percentage of the additional financing requirement covered also depends on the capital intensity. However, the data are equivalent because the capital intensity is always close to one. Therefore, the additional financing requirement tends to be the same as the expected variation in sales

## Conclusions

The findings in the literature and economic policy publications report that innovative firms are fundamental to economic growth, but suffer from major barriers to access to external financing due to the imperfections of the capital markets and their own intrinsic characteristics. These factors encourage the use of equity as the form of financing best suited to support innovative projects. It is therefore particularly useful to estimate the potential need for equity of innovative SMEs in order to ascertain whether they are affected by an equity gap.

During the last few years there have been various attempts, at the international level, to estimate whether an equity gap exists, and if so to assess its significance. However, there is still a great deal of uncertainty with regard to the method to be used for estimating the phenomenon, as an analysis of the main lines of investigation pursued in order to measure it reveals. Most of the approaches developed focus on the equity supply side, although there have been a few attempts, still in the minority but potentially amongst the most interesting, to analyse the problem from the demand side with the aid of a quantitative approach. This study adopts the quantitative approach outlined above, with the main aim not of producing a precise calculation of the equity gap, but of measuring the future equity requirement of the firms in one of Italy's regions. We identify the underlying causes of an equity requirement, with the ultimate purpose of comparing the figure produced for this requirement with the thresholds reported in the main international studies of the equity gap.

To achieve this, a sample of 4508 growing SMEs with registered office in the Emilia Romagna region was selected. An observation of the values used as input for the estimation model leads to the conclusion, first and foremost, that overall, investments per unit of sales are low, secondly, that the role of self-financing in fuelling growth is absolutely marginal, and thirdly, that it is essential for firms to be able to transfer a major proportion of their financing requirement to other non-financial enterprises. Assuming a constant indebtedness ratio throughout the period surveyed, for the sample as a whole, the additional need for financing generated by the growth in sales is covered, on average, by self financing (7.1%), by increasing current debts (59.5%), by new financial indebtedness (10.7%) and by new equity (22.8%).

One important new finding to emerge from the application of the estimation model is the direct, statistically significant relationship between additional equity requirement per unit of sales and the firm's size category and age; on the other hand, no significant differences were found with regard to firms' degrees of innovation. The results of this study vary somewhat from the pointers given by current theory, according to which small, new, innovative enterprises should be the ones to make extensive, if not prevalent, use of equity as a source of financing. Our findings, which underline the importance of this source of financing for the firms which are most consolidated in terms of age and size class, do not however contradict the literature on the subject. It is important to remember that we explicitly considered the role of current debt, which appears to be important in general but especially so for micro-enterprises and for young firms, which are also the types of companies which show the lowest need for equity; the inclusion of this variable, not always considered in the literature, is essential if firms' financial problems are to be interpreted correctly.

The results of the cluster analysis confirms that the degree of innovation cannot be considered the main discriminating factor when it comes to the differences in equity requirement per unit of marginal sale; while the regression analysis reveals that the enterprise's year of foundation, and thus its youth, appears to be the main discriminating factor when it comes to the difference in equity requirement for incremental unit of sales.

Finally, the study estimates the equity requirement in monetary terms. It appears to be relatively low in all contexts and in the various samples studied. Overall, assuming a constant indebtedness ratio, the equity requirement is assessed at 147.3 thousand Euros.

The cluster analysis shows that the highest average value of the equity requirement (645.9 thousand euro) is associated to the innovative firms in the cluster characterised by the higher growth of rate in sales.

As underlined on several occasions, although these values are not a specific estimate of the equity gap, overall the amount of equity required is in line with the thresholds identified by the main international studies, which could indirectly confirm the problem of a gap in the availability of risk capital for SMEs.

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