INNOVATION, ASYMMETRIC INFORMATION AND THE CAPITAL STRUCTURE OF NEW FIRMS

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ABSTRACT

Start-ups are essential contributors to economic development, but they often face several barriers to growth, including access to finance. We study their capital structure in their early years of operation through the lens of Pecking Order Theory, exploring how the pursuit of innovation influences firms' reliance on different types of finance. Panel analyses of 8273 German start-ups show that innovation activities are relevant predict start-ups' revealed preferences for finance. Effects on the type and order of financing sources depend on the degree of information asymmetries specific to research and development activities, human capital endowments, and the market introduction of new products and processes. New firms focused on research and development activities and with better human capital are less likely to receive informationally complex finance such as debt and will rely relatively more on owner and equity finance. Mixed evidence is found, instead, on the role of new products or processes. Our results suggest that the traditional pecking order theory does not hold for new firms, implying that owner and external equity play a much more prominent role for such firms. Then, managers and entrepreneurs should consider specific sources of finance and financial instruments in light of their innovative activities.

JEL codes: G32, O16, O30

Keywords: Innovation, information asymmetries, start-up, pecking order, entrepreneurial finance.

1. Introduction

A large amount of research has investigated the problem of firm capital structure with the aim to improve our understanding of the relationship between firm characteristics and financing choices. The increasing importance attributed to new firms in both academic (Haltiwanger, Jarmin, and Miranda 2013) and policy domains (European Commission 2021, 2016) has strengthened a particular interest in financing entrepreneurial ventures as enablers of growth. Despite all these efforts, however, many aspects of new firm financing are still unclear when the focus is on the provision of capital for high-risk investments in firms that are not only small and young but also highly innovative. As explained, for example, by Hall (2010) and Hall and Lerner (2010), the financing of R&D and innovation poses particular challenges, and these go beyond the simple identification of venture capital (VC) as the most appropriate answer to finance gaps in high-tech entrepreneurial contexts.

Over time, the academic literature has focused on the importance of asymmetric information as a relevant dimension for analysing small and young firms' capital structure (Nguyen and Canh 2020). A prominent theory building on this concept is Pecking Order Theory (POT), whose traditional version suggests that the sources of finance would be picked according to costs determined by information asymmetries, with internal finance being the cheapest – and thus always preferred when available – and with debt dominating equity in the firm's preferences for finance (Myers 1984; Myers and Majluf 1984). Since the original formulation of POT, the many empirical studies on this topic have not reached consensus on whether and to which extent these hypotheses apply to new firms (Frank and Goyal 2008). Several authors found evidence in support of the traditional pecking order of financing (Cassar 2004; Cosh, Cumming, and Hughes 2009; Robb and Robinson 2014), while others find that new firms tend to approach equity investors before seeking debt (Carpenter and Petersen 2002a; Paul, Whittam, and Wyper 2007; Vaznyte and Andries 2019; Neville and Lucey 2022). Moreover, there is a lack of empirical investigations on the intersection and more granular sequencing in using different sources of

capital (Cumming and Groh 2018; Farhat et al. 2018). Although several determinants of financing choices have been analysed very thoroughly (e.g., firm size and age), the role of innovation in capital structure dynamics is relatively under-explored, which is surprising given the importance of financial resources for R&D-intensive firms (Farhat et al. 2018).

In this paper, we investigate how different types of innovation are associated with the capital structure of new firms and provide novel longitudinal evidence on the financing choices of start-ups. Building on a POT framework, we use a sample of German start-ups to study how innovation is associated with information asymmetries that lead to a particular order and type of financing choices.

Systematic empirical evidence on longitudinal data is rare and fragmented because very few datasets include granular data on the spectrum of new firm financing sources while providing sufficient information on innovation activities. Notable exceptions are the Kauffman Survey (Chemmanur and Fulghieri 2014) and, more recently, the IAB/ZEW Start-Up Panel survey (Vaznyte and Andries 2019). As Farhat et al. (2018) discussed, data availability is one of the biggest challenges in the study of entrepreneurial finance. It is important to stress that the vast majority of empirical studies to date has focussed on new VC-backed firms or firms that receive a single type of capital, with counterfactuals defined by the absence of that specific source rather than by the presence of alternative sources (Cumming and Johan 2017). Although an extensive literature focused on small and large firms (Hall and Lerner 2010; Magri 2014, 2009), only a few studies have investigated how innovative activities broadly shape the financing choices of new firms (among them, Giudici and Paleari 2000; Cassar 2004; Paul, Whittam, and Wyper 2007; Vanacker and Manigart 2010; Robb and Seamans 2014), and our paper contributes to this stream of literature.

We address three main questions: (i) Do the financing choices of new innovative firms reflect a pecking order based on their informational opacity? (ii) Are different types of innovation relevant predictors of new firms' decisions to use specific sources of finance? (iii)

Does innovation affect the likelihood of choosing specific financing types compared to the alternatives? In analysing the capital structure of start-ups, we: 1) consider simultaneous and alternative financing choices; (2) include, on the one hand, different indicators of innovation inputs (i.e. R&D expenditures and human capital) and outputs (e.g. product and process innovation) and, on the other hand, multiple of sources of finance (owner capital, family and friends' money, internal finance, business angels, VC, and bank finance) to provide tests on an extended pecking order; (3) run the empirical analyses in a dynamic setting to alleviate concerns of endogeneity of financing choice.

The paper is structured as follows. In Section 2, we present a literature review, identify the specific gap we address in this contribution, and formulate testable hypotheses. Section 3 describes the data and the econometric methods used in the empirical analysis. In section 4, we present and discuss our results. We draw the paper to a close in section 5 by discussing its implications and limitations, and suggesting steps that might be considered in further research.

2. Theory and hypotheses

2.1. Information asymmetries and capital structure of new firms

Among existing capital structure theories, pecking order theory is ideally suited to analyse the financing choices of small and young firms (Cassar 2004; Cosh, Cumming, and Hughes 2009; Martinez, Scherger, and Guercio 2019; Mina, Lahr, and Hughes 2013; Robb and Robinson 2014; Vaznyte and Andries 2019). A key reason is the centrality of adverse selection as a driving construct, stressing the existence of information asymmetries between the managers/owners and potential finance suppliers, whereby only the former know the 'true' value of the firm. In what follows, we begin by discussing the original formulation of POT. We will then elaborate on how its predictions change in the context of innovative start-ups, that is to say, in an investment domain characterised by the strongest information asymmetries.

Building on an information economics framework, the original POT formulation posited the existence of a hierarchy of financing choices (Myers and Majluf 1984). This order is defined according to the asymmetric information level that is faced by each financing source: higher levels of asymmetric information lead external investors to demand a "lemon premium" (Akerlof 1970) because of adverse selection risks generated by a lack of information about the investment opportunity in the finance-seeking firm. According to POT, when choosing between external and internal finance the latter is always preferred because it does not entail asymmetric information and is the cheapest option. When external funds are necessary, debt should be preferred to equity because banks can perform efficient screening functions that minimise adverse selection problems (Diamond 1984; Stiglitz and Weiss 1981). Conversely, equity investors cannot discern the firm's 'true' growth potential. When the owners offer equity, they implicitly renounce future cash flow and suggest that the firm might be overvalued. Hence, the risk perceived by external investors will increase and, since equity investors cannot benefit from collaterals to cover their losses and do not have a priority claim on the firm's cash flow, they will ask for higher returns on their capital.

As described in the original POT, this order of choice has been subject to many empirical tests. Interestingly, there is little agreement on whether POT can be considered a general theory of firm financing choices (Fama and French 2005; Frank and Goyal 2003; Lemmon and Zender 2010). Views differ on the specific contexts in which the pecking order might apply (Leary and Roberts 2010; Botta and Colombo 2022), and contrasting results are found on the choice of debt vs equity as external sources of financing (Frank and Goyal 2008).

When POT is applied to populations of smaller and younger firms, the framework might need substantial adjustments (Rao et al. 2021). Indeed, previous studies focusing on capital structure show that, regardless of the theoretical perspective, small firms are always peculiar in their financing choices. For instance, a recent study by Samuelsson, Söderblom, and McKelvie

(2021) shows that a new firm's initial financing decision will create a lock-in effect, whereby the firm is more likely to receive the same source of finance again and again.

Deviations from the pecking order already emerged in the studies by Frank and Goyal (2003) and Fama and French (2005), which showed that high growth firms were more prone to asymmetric information problems and more likely to rely on equity rather than debt finance. As suggested by Fulghieri, García, and Hackbarth (2020), when the level of asymmetric information is high, equity financing can dominate debt financing, with the counterintuitive result that this would happen even when an individual asset could be financed by debt if taken in isolation. The authors conclude that "the relationship between asymmetric information and choice of financing is more subtle than previously believed" (Fulghieri, García, and Hackbarth 2020, 33). More recent theoretical modelling integrates asymmetric information and financial market imperfections as explaining factors (Tirelli and Spinesi 2021). Their model, which includes both innovation and financing decisions, supports the preference of equity over debt for young start-up firms due to substantial informational opacity.

Extant empirical research shows that start-ups are often forced to raise external funds because they lack internal finance (Fryges, Kohn, and Ullrich 2015). Moreover, new firms have to deal with credit rationing due to their higher asymmetric information levels than larger and older firms (Carpenter and Petersen 2002b; Stiglitz and Weiss 1981). From the traditional POT perspective, debt financiers should face relatively low information asymmetries because the value of debt has a fixed remuneration and is often guaranteed by some collateral, which reduces the "lemon premium". Therefore, once the borrower's asymmetric information levels can be decreased and the 'true' value of the firm is revealed, there will be only minor changes in the value of the attached debt securities. Accordingly, debt capital should be relatively cheap. Conversely, equity investors do not require any collateral and expose their funds to substantial risks, thus facing a high level of information asymmetries, which command an additional "lemon

premium" compared to debt financiers (Berger and Udell 1998; Carpenter and Petersen 2002a; Vanacker and Manigart 2010; Vaznyte and Andries 2019).

This line of thought also highlights that standard POT does not account for all the decisions that can be made about different sources of finance. New firms raise funds through a broad set of financing sources, including owner funds, family and friends' capital, retained earnings, bank debt and private equity (venture capital and business angel), with more recent additions including crowdfunding and initial coin offerings. Therefore, if information asymmetries determine the financing hierarchy, we would expect new firms to follow a pecking order where the sources of financing that are better able to cope with informational asymmetries are chosen first, possibly leading to lower commitment to debt capital (Lefebvre 2021). Several studies have observed that start-ups prefer private equity to bank debt (Carpenter and Petersen 2002a; Fama and French 2005; Paul, Whittam, and Wyper 2007), suggesting that the superior abilities of professional investors offset a higher cost of private equity capital in evaluating new firms and managing information asymmetries through screening and monitoring (Gompers and Lerner 2001). In addition, it is well established in the literature that private equity investors also provide non-financial resources by participating in the firm's management, supporting the owners with their networks and complementary assets, ultimately contributing to firm growth and positive exit events (Bertoni, Colombo, and Grilli 2011; Gompers and Lerner 2001). Then, new firms with higher levels of informational asymmetries would prefer owner finance and friend and family funds as a first option. Accordingly, when internal funds are exhausted, they would approach business angel and venture capital funds as sources of intermediate equity. This preference exists because of the advantage these sources have when coping with high levels of asymmetric information while being cheaper than debt once non-monetary benefits are accounted for. Lastly, as they consolidate their collaterals, firms will have access to debt and public equity (Berger and Udell 2006).

2.2. Innovation and firm capital structure

POT posits the existence of a financing hierarchy based on asymmetric information and adverse selection costs. The few prior studies on the validity of POT for start-ups seem to suggest that the existence of a financial hierarchy can be context-dependent and that several firm characteristics might influence the adherence to a strict pecking order. For instance, Robb and Robinson (2014) find evidence that most new firms' early operations are financed through a relevant share of debt finance despite their young age. The results of this study seem to be in line with the pecking order predictions, which is surprising considering the problems of informational opacity generally associated with start-ups and the advanced development of private equity markets in the United States. In a more recent contribution, Vaznyte and Andries (2019) find that start-ups with different levels of entrepreneurial orientation will make different financing choices based on the distinct costs and benefits perceived from different types of finance. We extend this line of research and consider other aspects of innovation as determinants of information asymmetry associated with deviations from standard POT predictions. In addition to the characteristics that they share with all SMEs as investment propositions (no track record and lack of collateral) (Gompers 1999), innovation projects entail technological and market uncertainty (Coleman and Robb 2012). Investments in innovation can generate intangible assets (e.g., intellectual property or know-how) which are difficult to evaluate from outside the firm and are illiquid if seen as possible collateral. These features increase start-ups' overall risk, informational opacity, and probability of bankruptcy. More innovative start-ups will experience worse asymmetric information problems than less innovative companies (Aghion et al. 2004; Hall 2002, 2010; Hogan and Hutson 2005; Neville and Lucey 2022) even though their innovative ideas may be more profitable business opportunities. As a result, credit rationing can be extreme for small, young and innovative firms as far as the most risk-averse borrowers are concerned (Leary and Roberts 2010; Zhang 2021).

Framing these arguments in predictions of POT is a non-trivial task. The preference for internal over external finance can be relatively independent of innovation whenever transaction costs exist (Cosh, Cumming, and Hughes 2009; Hall 2009; Magri 2009; Mina, Lahr, and Hughes 2013; Revest and Sapio 2012). The importance of internal cash-flow is well documented (Brown, Fazzari, and Petersen 2009; Magri 2014),[1] and the relationship between internal and external finance is especially relevant when in the context of high-tech SMEs (Neville and Lucey 2022; Himmelberg and Petersen 1994). Precisely because of its importance, the possibility to use internal finance should be explicitly included in empirical analyses, not least because this has been identified as a crucial determinant of selection into entrepreneurship (Jensen, Leth-Petersen, and Nanda 2022).

The relative preference for debt or equity is more complicated when no internal resources are available and the firm pursues innovation activities. If we follow Spence (2002) signalling framework, it can be argued that indicators of innovation can play a distinctive role among firm characteristics that can be evaluated as proxies of firm quality by external capital providers.[2] Different aspects of innovation imply different degrees of uncertainty and information asymmetries, and these can and should be integrated in a pecking order perspective in theorising and analysing empirically the capital structure of new firms. Existing evidence on small firms suggests that innovators rely more on internal resources and less on bank loans and that high technology firms issuing equity have a substantially higher probability of performing R&D activities (Magri 2009, 2014). However, only a few studies have investigated the financing hierarchy of *new* firms in light of their innovative activities, and almost all of them have focused on one source of finance at a time rather than considering simultaneously the several financing options that are available to entrepreneurs (Cassar 2004; Giudici and Paleari 2000; Paul,

[1] For a broader discussion on the relationship between Schumpeterian innovation and firm financial constraints see Hajivassiliou and Savignac (2008), Hottenrott and Peters (2012) and Lahr and Mina (2021).
[2] Following this perspective, several contributions have explored the effect of innovation on investment selection behaviours in venture capital markets (Audretsch, Bönte, and Mahagaonkar 2012; Baum and Silverman 2004; Conti, Thursby, and Thursby 2013; Conti, Thursby, and Rothaermel 2013; Häussler, Harhoff, and Müller 2012; Hsu and Ziedonis 2013; Mann and Sager 2007; Lahr and Mina 2016).

Whittam, and Wyper 2007; Robb and Robinson 2014; Vanacker and Manigart 2010; Samuelsson, Söderblom, and McKelvie 2021). This gap in the literature is partly due to the scarcity of good quality data on new firms and partly because the datasets that do exist rarely incorporate both (multisource) financial *and* innovation data. Also, when appropriate datasets are constructed by matching complementary data sources, they tend to have information only on a focal source of finance (typically venture capital) rather than a full spectrum of financing options, which is instead necessary for a study of financing hierarchies (Cumming et al. 2019).

Contrasting results about the relative importance of debt are obtained in Fryges, Kohn, and Ullrich (2015) and Brown et al. (2012). Whereas Fryges, Kohn, and Ullrich (2015), analysing 2007-2008 German data, find a positive and perhaps two-way relationship between bank debt and R&D intensity, Brown et al. (2012) found a negative relationship between high-tech firms and the use of bank loans for the period 2007-2009. These discrepancies may be due to turbulence generated by the financial crisis of 2008. Vanacker and Manigart (2010) explore the importance of debt capacity in a pecking order setting, finding that firms with a larger share of intangible assets are more likely to fund their activities with equity rather than debt. Lahr and Mina (2015) argue that innovation can explain the observed deviations from the standard pecking order. However, their comparative study of UK and US SMEs suffers from the limitations of cross-sectional data, which did not allow testing in a longitudinal framework.

Our paper contributes to this literature by using multiple indicators of both innovation and finance types in a dynamic framework and testing how different aspects of innovation are associated with a hierarchy of financing choices based on information asymmetries.

According to POT, we posit that the type finance obtained is based on the firms' level of information asymmetries. Thus, when a start-up engages in innovation activities, it will increase its informational opacity. In a financing hierarchy, innovation inputs, such as investments in R&D, would negatively influence the probability of accessing more informationally complex

sources of finance, in line with the results of Wang and Thornhill (2010) in the case of large firms. Our first hypothesis is:

Hypothesis 1.a. In a hierarchy of financing choices, new firms with higher levels of R&D investments will be less likely to access more informationally complex sources of finance.

Not all activities usually branded as "innovative" may exacerbate informational asymmetry. Introducing a new product in the marketplace can be associated with more stable cash flows, which could help service the debt; similarly, new processes could optimise production costs, providing new resources in the balance sheet and reducing adverse selection costs. As a result, the firm's informational opacity could be reduced, thus facilitating access to more informationally complex sources of finance in a finance hierarchy. We hypothesise that:

Hypothesis 1.b. In a hierarchy of financing choices, new firms that introduced new products or processes to the market will be more likely to access more informationally complex sources of finance.

A further indicator of asymmetric information that is particularly relevant for startups firms is the human capital level of the firm and of the founder. Previous literature has established a connection between the firm's human capital (Berk, Stanton, and Zechner 2010; Jaggia and Thakor 1994), the founder's human capital (Baum and Silverman 2004; Colombo and Grilli 2005; Honjo 2021) and the capital structure and financing decisions of the company. Part of this literature focused on other dimensions and perspectives of human capital. In this paper, we focus on human capital as a proxy of informational opacity and firm innovative activities. From an asymmetric information perspective, firms with a higher level of human capital are more likely to be involved in complex activities that increase the informational opacity of the firms.

Therefore increased human capital, such as a higher number of graduated employees or a highly educated founder might lead to more issues in accessing sources of finance that are less efficient in coping with asymmetric information. Therefore, we hypothesize as follows:

Hypothesis 1.c. In a hierarchy of financing choices, new firms with a higher level of human capital will be less likely to access more informationally complex sources of finance.

From a complementary perspective, we are also interested in how individual sources of finance are related to innovative activities. In line with the contribution of innovation to the firm's informational opacity, we would expect that firms with higher R&D investments will be more likely to use equity and owner finance and less likely to receive debt finance compared to other firms. On the other hand, we would expect an opposite relationship for firms that introduce product or process innovation, since these might be associated with lower informational opacity. We, therefore, propose that:

Hypothesis 2a: Start-ups with higher investment in R&D will be more likely to rely on owner finance and equity finance than other start-ups, and less likely to receive debt finance.

Hypothesis 2b: Start-ups introducing product or process innovations will be more likely to rely on owner finance and debt finance than other start-ups, and less likely to rely on equity finance.

In line with this reasoning, we further argue that when focusing on specific sources of finance, startups with higher human capital will be more likely to be informationally opaque and, therefore, more likely to access sources of finance that can cope better with informational opacity, such as owner and equity finance rather than debt. Accordingly, we hypothesis as follows:

Hypothesis 2c: Start-ups with higher levels of human capital will be more likely to rely on owner finance and equity finance than other start-ups, and less likely to rely on debt finance.

Finally, against the general prediction of the traditional POT, we expect that innovation will drive firms towards obtaining equity rather than debt or other sources of finance. That is, firms that suffer from worse informational asymmetries would be more likely to choose equity capital compared to debt or other sources of external finance. We hypothesise that:

Hypothesis 3a: Among firms that receive external financing, the likelihood that they will be financed by sources other than external equity is negatively related to their innovation inputs.

Conversely, the introduction of product or process innovations can contribute to decreasing firms' informational asymmetries. Therefore, firms that introduced these types of innovation should obtain debt or other sources of finance compared to equity, because these sources face reduced adverse selection problems, and these types of innovations might reduce the level of informational opacity. We test that:

Hypothesis 3b: Among firms that receive external financing, the likelihood that they will be financed by sources other than external equity is positively related to innovation outputs (i.e., the introduction of process and products innovations).

3. Data and Methodology

3.1. The sample

The database we use for this study is the IAB/ZEW Start-up Panel (KfW/ZEW, 2014)[3]. This is one of the few datasets that observe very young firms from a longitudinal perspective by building on repeated surveys of German start-ups and micro firms. This important segment of the economy is rarely covered in standard surveys of firms, as these do not capture observations until a company has at least one registered employee (many start-ups have no employees at all at the beginning of their life). The IAB/ZEW Start-up Survey draws samples from Creditreform, the largest rating agency in Germany, applying the condition that a firm must be run by at least one full-time entrepreneur if it is to be included in the database. An important characteristic of the final sample is that firms have to be three years of age or younger when they are interviewed for the first time. Furthermore, the sample is stratified to cover all industrial sectors, with an over-representation of newly founded technology-based firms. The survey aims to interview about 6,000 firms in each wave. The data collection is done through computer-aided telephone interviews (CATI). When approaching a firm for the first time, the operator collects information also for the previous three years. As we have anticipated, this dataset has the rare feature of including information about both financial structure and innovation, and the longitudinal format gives us the opportunity to control for the effects of innovation on the capital structure over time.

We use the anonymised 2014 version of the dataset, covering the 2005-2013 years of activity.[4] Working with innovation data means that firms disappear from the sample without providing a specific reason (Mairesse and Mohnen 2010). To provide a minimum level of longitudinal observations, we drop firms that are observed for less than three consecutive years. The final panel is made of 8,273 firms surveyed for a minimum of three straight years to a maximum of eight consecutive years.

[3] Before 2014 this database was known as KfW/ZEW Start-up Panel.
[4] The first two years of data (i.e., 2005-2006) only contain information about the firm's cost, investments and revenues and exclude information on innovation. Therefore, they cannot serve the purpose of this study.

>>>INSERT TABLES 1-4 ABOUT HERE<<<

3.2. Estimation strategy

We develop our analysis in three steps. In the first step, we perform a test on the order of revealed preferences, investigating how different innovation indicators affect the probability that a firm's capital structure will belong to a class with sources of finance more or less able to deal with informational opacity.[5] In this kind of empirical set-up there is often endogeneity due to simultaneity and reverse causality bias. Having a longitudinal dataset dramatically reduces this risk because we can control for past values. In the second step of the analysis, we ask whether innovation influences the probability that a firm obtains any type of finance and more than 50% of total finance from a single type of financing source, testing if each of these relationships stands in a panel framework. Finally, we perform a complementary test on the probability of obtaining more than 50% of debt or other financing sources compared to the likelihood of receiving more than 50% of equity.

We begin by classifying firms into different groups based on the combinations of their financing sources. In this specification, we consider internal finance, owner finance, equity funding and debt funding. As shown in Table 1, internal finance includes retained earnings and sales; owner finance consists of owner deposits. Equity finance includes venture capital and mezzanine financing; debt includes long and short-term debt. Our ordinal dependent variable is constructed so that the minimum value is associated with the lowest adverse selection costs (owner finance) and the higher values are associated with sources of finance that face the highest levels of information asymmetries, as represented in Table 5.

[5] We stress that our data indicate the types of financing obtained by firms, but contain no information on whether firms have applied for other types of finance and were rejected. In other words, without observation of finance-seeking behaviours, we can only observe the "revealed preferences" of firms.

The classes we define are mutually exclusive and are used to test how specific firm characteristics influence the probability of accessing a specific type of finance. The order of choice we assume implies that debt is the source with the highest adverse selection costs for start-ups, as we argued in the theory section, and that private equity operators are able to cope with start-ups informational opacity and therefore being competitive in providing capital. We specify two hierarchies. The first includes owner finance, family and government funds (start-up grants and bridge money), equity and debt, combined in 5 and 7 classes, respectively. The second drops owner finance to provide a more straightforward test of the hierarchy between the external sources of finance, which are combined in 4 and 7 classes. Because of the ordinal nature of our dependent variable, we chose an ordered Logit regression model, following Kaplan and Zingales (1997).

We move to the second step in our analysis by creating binary dependent variables that indicate whether firms have received a specific type of finance in each year of the panel, and we analyse the determinants of the likelihood of obtaining a single type of financing, including owner finance, equity and debt. In addition, we perform complementary tests on the probability of receiving more than 50% of a given type of finance in a specific year in a panel specification. Because of the binary nature of these dependent variables, we apply panel Logit regression models.[6]

Finally, we build a categorical variable that reflects whether the largest share of a firm's external finance in a given year comes from debt, equity or other external sources (family and friends, government funds and a residual category). We use a multinomial logit model to investigate if firms that perform innovative activities have a different likelihood of obtaining the majority of funds in a given year in the form of debt or other sources compared to equity.

>>>INSERT TABLE 5 ABOUT HERE<<<

[6] The results of simple Logit models are available upon request. All the statistical tests confirmed the better fit of all panel specifications.

3.3. Independent variables

The main objective of this study is to identify the effects of several indicators of innovation activities on the capital structure of start-ups. R&D expenditures indicate the efforts that a firm makes in generating innovations. These are closely linked with the subsequent observation of patents and prototypes and are usually risky investments that increase firms' informational opacity (Griliches, Hall, and Pakes 1991; Hausman and Griliches 1984). We include yearly R&D expenditures scaled by turnover and with a one-year lag, winsorised at 1% and 99%.

To explore how innovation outputs rather than inputs affect financing choices, we use two dummy variables indicating whether the firm has introduced a new product or a new process in the reference year. These variables are good innovation indicators in line with the European Community Innovation Survey design and the Oslo Manual. New products are innovations associated with measurable market outcomes. As such, they are more transparent signals to investors relative to R&D in that they are directly observable as assets that an external supplier of capital can value. This reduces the overall informational opacity of the firm. New processes are also 'realised' novel ideas. Rather than opening up new market niches, they tend to reduce production costs, increasing profit margins and the competitive advantage of firms on the market. Interestingly, their effect from an asymmetric information perspective is not straightforward since they might not be recognisable to an external investor, and their value might not be easy to estimate.

Then, we proxy firm and founder human capital respectively with the number of graduates employed by the firm (standardised on total employment) and with a dummy variable indicating if the founder has a degree, in line with proxies used by previous studies (Bartelsman, Dobbelaere, and Peters 2014; Honjo 2021). As discussed in the hypotheses development section, firms with a higher level of human capital tend to be more knowledge-intensive investment

propositions (which adds to the firm's share of intangible over tangible assets), contributing to increased informational opacity. We expect these variables to negatively correlate with financing sources that entail higher adverse selection costs.

Control variables include firm characteristics such as age, size, profit margin, and a dummy variable indicating whether the firm has obtained public support as loans or subsidies. The maximum level of information asymmetry is expected to occur in a firm's first years of life. It is plausible to expect that younger firms will first access sources able to face lower levels of information asymmetry, such as internal finance, family and friend's finance and owners' finance. Higher profit margins should be negatively related to external finance and positively related to the probability of accessing internal finance. On the one hand, public support in the form of loans or subsidies might be important as an incentive for entrepreneurship, while providing a strong certification effect for external investors. Thus, we expect that firms that have obtained public support will be more likely to receive external finance (both equity and debt).

All regressions include a set of industry dummies (presented in Table 2) and year dummies. Descriptive statistics and correlations are reported in Tables 3 and 4.

4. Results

The first step of our analysis concerns the impact of innovation on the order of financing sources. We do not simply focus on pairwise (revealed) preferences but aim to identify a hierarchy of combinations of sources of finance on a continuum of adverse selection costs. We divided the sample into four different classes (Table 5), with the first two including owner finance, and the last two including types of external finance only. The classes are mutually exclusive combinations of different kinds of finance, and the lower levels of our ordinal dependent variable are the ones entailing lower adverse selection costs. The ordered Logit models estimate the effect of each covariate on the probability of a firm falling into a higher or lower class. All these models are estimated with a random effect panel specification.

Table 6 and Table 7 present the econometric estimates of ordered Logit models, including odds ratio. All models, with or without internal finance, consistently identify a negative relationship between R&D expenditures and an order of choice that reflects increasing adverse selection costs. The odd ratio of 0.364 in Table 6, Model 2, means that, assuming the theorised order of revealed preferences, an increase of one unit in the ratio of R&D activities on turnover will experience a reduction of 64% in the odds of being financed with capital associated with higher adverse selection.

Introducing product innovation is always associated with an odds ratio lower than one but never statistically significant. The opposite, still not significant, is observed for the introduction of process innovations.

The effect of a firm's human capital is negatively and significantly associated with the odds of receiving finance with capital associated with higher adverse selection. Since this indicator captures intangible assets, this is consistent with the impact of R&D activity, as expected. This effect is stronger once we exclude owner finance from the financing hierarchy, corroborating the idea that a more significant portion of educated workforce is associated with activities that are informationally opaque for external financiers. Surprisingly, we do not observe a clear effect of the founder's human capital on the hierarchy of financing choices, with very small coefficients that are never significant.

As far the control variables are concerned, odds ratios are in line with our expectations. Older and larger firms can access finance types that are more complex from an informational opacity perspective. This pattern is consistent with the pecking order theory's prediction and the idea that a firm's informational opacity decreases as age and size increase. Profit margin also follows the pecking order prediction, indicating that a more profitable firm can afford the higher costs of more complex sources of finance. Finally, public support reduces informational opacity and seems to ease firms' access to costlier sources of finance. The overall results are consistent with our first hypothesis *H1.a*, but we do not find supporting evidence on the consequences of

introducing product or process innovations *H1.b*. In addition, we find mixed support for H.1.c, with only firm human capital significantly affecting the type of finance received.

>>>INSERT TABLE 6 AND TABLE 7 ABOUT HERE<<<

The Logit estimations of the likelihood of obtaining a specific source of finance (Table 8) show that R&D expenditures are positively and strongly correlated with owner finance and equity finance, confirming our expectations. Furthermore, the odds ratio of R&D on debt are lower than one and statistically significant, in line with theoretical prediction. The odds ratio in Table 8, model 6, suggests that a unit increase in the ratio between R&D expenses and turnover leads to a reduction of 32% in the odds of obtaining debt finance. The majority-of-finance results in Table 9 fully confirm the negative association between R&D investment and debt and the positive relationship between R&D investments and owner and equity finance.

>>>INSERT TABLE 8 and 9 ABOUT HERE<<<

As expected, introducing a product or a process innovation is associated with an increase in the probability of obtaining all types of finance compared to other firms. The panel logit estimations of the likelihood of receiving any amount from specific finance types reveal a clear positive correlation between owner and debt finance to innovation outputs, respectively leading to an increase in the odds of obtaining debt (product: 36%, process 54%) and owner capital (product: 36%, process: 67%). Results for these two sources are consistent when we focus on the probability of obtaining more than 50% of finance (Table 9). In contrast, the coefficient for equity finance, which was already weak in the previous estimation, loses its significance. Innovation output indicators seem to decrease the informational opacity of the firm as an investment proposition, thus reducing the cost of access to some sources of financing. On the one

hand, introducing new products can imply future cash flow that could better service the debt. On the other hand, process innovations can affect costs, freeing financial resources and leaving balance sheets in better shape, to which debt finance should react positively. However, introducing new products or processes does not seem to affect the probability of obtaining equity financing. We instead observe that introducing a product innovation has a negative, but non-significant, impact on the odds of obtaining the majority of equity financing. This can be plausible if the entrepreneur is on course to launch on the market a product that is already developed and is not inclined to share the attached cash flows with a new investor. Overall, the results are in line with the financing hierarchy based on adverse selection costs and with our expectations.

We find that firm human capital is positively and significantly associated with equity financing in both specifications. On the other hand, a negative and significant relationship with debt is observed only in the majority-of-finance complementary analysis. These signs align with the expectations that firms employing highly skilled people, whose knowledge can be a source of informational asymmetry relative to potential finance suppliers, are less likely to access more informationally complex sources of finance. On the other hand, the founder's human capital is never significant when firm-level human capital is considered, in contrast with recent findings (Honjo 2021).

Results for the control variables are very coherent with our expectations and reveal that older firms are more likely to be financed with debt and less likely to be funded with owner finance. Size seems to increase the probability that a firm is financed through equity and debt and reduce the likelihood that it will be financed with the owner's funds. Profit margins behave as expected, being negatively correlated with external sources of finance and with owner's equity. Public support positively affects the probability of obtaining any kind of finance, even when we consider the likelihood of receiving more than 50% of a specific source of finance.

We can draw the following conclusions from these two sets of econometric estimates. We find full support for our first hypothesis *H2.a*, confirming that start-up R&D investments are associated with higher informational asymmetries and, accordingly, they are not suitable for debt financing, but they are positively related to equity and owner's financing. However, we find mixed support for *H2.b* on product and process innovations that seem to positively influence the probability of receiving owner finance and debt finance but are not significant determinants of the likelihood of equity financing. Again, we find mixed support for H2.c, with only firm human capital exhibiting a significant, positive, relationship with the likelihood of obtaining equity finance, but never clearly related to debt and owner financing.

Finally, Table 10 shows the results of a multinomial logistic regression. Both columns report the effect that the coefficients have on the probability of accessing a majority of either Debt or Other sources of external finance compared to Equity. The negative and significant coefficient of R&D expenditures for both choices suggests that higher R&D investments significantly decrease the probability of choosing Debt or Other sources of finance. As expected, this negative relationship is confirmed when we look at the effects of human capital. Founder human capital, instead, has the expected sign, but it is not significant.

Introducing a new product or process does not seem to matter when considering alternatives to equity financing. The other control variables are not significant, except for profit margin, which, as expected, is positively related to choosing a different source of funding than debt, in line with the owner's aim to appropriate all the firm's cash flow.

Overall, the multinomial regression results support hypothesis *H3.a,* but we do not find significant evidence on process and product innovation to support *H3.b*.

>>>INSERT TABLE 10 ABOUT HERE<<<

All in all, we find significant evidence of the role of informational asymmetry in the financing choices of young firms, uncovering a significant role for R&D expenditures, while results are

less clearcut for product and process innovations. However, several potential factors might be driving our results. Potentially, firms introducing new product and investing in R&D might send a positive signal to the market, showing the ability to successfully profit from their investments. Therefore, we test for a possible interaction between R&D and product innovation, whose findings are inconclusive (unreported). In addition, our results might be driven by specific sectors or yearly characteristics. Therefore, following the suggestions of Neumayer and Plümper (2017), we repeat our estimation excluding one sectors and one year at a time (unreported). We find that our results are robust to such potential bias.

5. Conclusions

During the last two decades, many policy initiatives have been designed to stimulate the birth and growth of new firms. Start-ups have been firmly placed at the core of broader processes of economic growth and net job creation (Haltiwanger, Jarmin, and Miranda 2013). Notwithstanding these efforts, new ventures still face considerable challenges, and one of the most concerning remains their access to finance (European Commission 2021, 2016). Because innovative firms seem especially vulnerable to this kind of barrier to growth, it is essential to gain as detailed a picture as possible of how, why, and under what circumstances capital flows in certain directions and towards specific types of firms.

In this study, we focus on the role played by different aspects of innovation in the context of start-ups' capital structure decisions. We have adopted a pecking order theory framework. We posited that innovation is associated with information asymmetries that strongly influence the revealed preference for different types of finance (Fulghieri, García, and Hackbarth 2020; Tirelli and Spinesi 2021). To the best of our knowledge, only a few studies exist that analyse simultaneously a range of financing options and do so in a longitudinal setting. Moreover, we have considered the predictors of each type of finance, but we have also accounted for the combinations and order of finance sources. We have analysed rare and high-quality longitudinal

data on a sub-population of systematically under-represented firms in standard microdata. We found that start-ups' R&D investments and firm human capital as innovation inputs are critical determinants of the type of finance obtained and that their contribution to firms' informational opacity supports the idea that new firms pecking order of finance is based on asymmetric information and adverse selection costs. We do not have clear evidence regarding the effect of product and process innovations in reducing a firm's informational asymmetries in a hierarchical framework. Still, we find significant effects when we test the likelihood of accessing them as individual sources of finance. This conflicting evidence might be explained by limitations related to the available data, which do not allow us to control for the number of products or process innovations introduced, but only provide a binary indicator, in line with the well-established tradition of Community Innovation Surveys in Europe. In addition, an intrinsic limitation might be related to the theoretical framework that we adopted. This paper focused on the POT to leverage the concept of adverse selection and informational asymmetries. However, a stream of literature has tried to explain capital structure choices by adopting combining insights from multiple theories (Serrasqueiro and Nunes 2012). This might be a fruitful avenue for future research that might shed additional light on new firms financing choices. At last, we also confirm and extend previous findings investigating the importance of internal finance in high-tech firms, by leveraging the presence in our sample of both high-tech and traditional start-up (Neville and Lucey 2022; Himmelberg and Petersen 1994).

All in all, our results highlight that the traditional pecking order theory does not hold for all young firms and that innovation activities, as drivers of informational opacity, must be taken into account when investigating new firms' capital structure. In addition, our results highlight, with a comprehensive set of indicators, the fundamental and systematic role that owners' funds and external equity have in the financing of innovative startups.

These results have relevant practical implications. From a managerial perspective, our results can be helpful for entrepreneurs that have started or are planning to start a new innovative

business. Managers must take into account the empirical (behavioural) regularity that certain types of investors are less likely to provide finance at reasonable costs depending on the firm's characteristics and innovation activities. This indicates that in developing the firm's business model, financing decisions must be closely aligned with innovation strategies linked to the particular stage of development of the firm. This result should also be kept in mind by investors in innovative startups concerning hybrid instruments that can reduce the adverse selection costs associated with different types of finance, reducing asymmetric information and informational opacity. A promising avenue, for instance, might be the use of big data analytics to collect and elaborate large amounts of data to be used as decision support systems capable of offsetting the inability of certain kinds of investors to evaluate innovative firms as investment propositions.

This study has, of course, some limitations, which can also offer interesting directions for future research. Firstly, we only observe the type of finance that is obtained by the firms, but we do not observe if firms were trying to obtain finance from a different source and were rejected. Secondly, it is important to emphasise that the sources of finance we considered are interdependent. The research design of this study investigates co-occurrences but does not delve deeper in the mechanisms that correlate one source to the others. For instance, recent evidence shows that firms receiving venture capital investments are less likely to obtain, afterwards, government-sponsored loans (Giraudo, Giudici, and Grilli 2019), while they increase the likelihood to receive venture loans (Lehnertz, Plagmann, and Lutz 2022). Conversely, receiving public subsidies or government grants might signal start-up quality to future capital providers, increasing the likelihood to receive bank debt or venture capital investments (Hottenrott, Lins, and Lutz 2018; Berger and Hottenrott 2021; Svetek 2022; Santoleri et al. 2022; Howell 2017). Similarly, recent findings demonstrate the existence of a substitution effect between venture capitalists and business angels, showing that those sources work through isolated streams of funding (Hellmann, Schure, and Vo 2021). This literature suggests that the interactions between new firm financing sources are governed by complex dynamics. Such evidence hints that what

happens during the first years of a firm's life might have a significant impact on the sources of finance that the venture will be able to obtain in the future. A recent paper by Samuelsson, Söderblom, and McKelvie (2021) leverages this dynamic by applying path dependency analysis, showing that new firm financing exhibits a certain level of persistence. Future research might investigate further the dependencies between old and new financing sources, aiming to provide new evidence based on data comprising a large spectrum of financing sources.

This leads us to discuss an additional limitation of our results. Indeed, despite using a level of detail on the sources of finance uncommon in previous studies, we are aware that in recent years new financing tools have emerged, including accelerators, crowdfunding, new financing techniques for equity capital (Parra and Winter 2022) and venture loans (Lehnertz, Plagmann, and Lutz 2022) (for a comprehensive list, see Bertoni et al. (2021) and (Rao et al. 2021). New types of finance may grow from niche markets to mainstream sources of entrepreneurial finance, but it is still early day, and these segments of the external capital markets are either not yet included in official statistics or not yet covered by sufficiently long time series. There is no doubt that they can be included in further extensions of POT studies, and we can expect a relevant impact on capital structure dynamics. For instance, innovation practices such as crowdfunding have the collateral effect of decreasing information asymmetries. Crowdfunding, specifically, has the peculiarity of being not only a channel to raise financial resources, but also a platform that allows interaction between customers and founders. These interactions are usually open to market observers, and might therefore lead to lower informational opacity, and as consequence to lower financing costs (Giudici and Rossi-Lamastra 2018). Similarly, the creation of innovation ecosystems at the regional and national levels has led to increased collaborations among innovative firms and other stakeholders such as capital providers (Rossi et al. 2022; Haider Alvi and Ulrich 2023). Undoubtedly, this context offers new opportunities, but also creates new strategic and organisational challenges for firms, which are worthy of more research (Radziwon and Bogers 2019). On this line, we highlight that the

regional dimension is also extremely relevant in light of the role of local banking development for the acquisition of debt finance (Deloof, La Rocca, and Vanacker 2019). We cannot control for this type of variable due to data anonymization, and we let future research investigate this insightful direction as a way to better understand new firms financing choices.

In addition, the data that we analyse follow new firms for several years in a row. Commonly to similar studies, our database suffers from panel attrition and some firms exit from the sample for reason that we cannot distinguish. Particularly, we do not know if exited firms were bankrupt or refused the interview for other reasons. This should be taken into account when reading our results, although such occurrence is common with other observational studies.

Finally, while we have covered the antecedents of capital structure, the implications of financing hierarchies for the long-term growth of firms provides an exciting continuation of this line of enquiry, and therefore fertile ground for further research.

6. Declarations of interest statement

No potential competing interest was reported by the authors.

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Tables

Variable name	Variable description
Internal Finance	Firm has obtained internal finance; specifically, the entrepreneurs were asked if in the reference year they used sales from running operations or retained earnings from previous years, or income from interest, royalties or provisions to finance their investment
Owner finance	Firm has obtained owner finance in the reference year, particularly deposits
Equity Finance	Firm has obtained equity finance as private equity, venture capital, capital from business angels or subscription of shares by third parties or mezzanine capital.
Debt Finance	Firm has obtained debt finance as long-term or short-term loans
Maj. of Internal Finance	Firm has more than 50% internal finance
Maj. of Owner Finance	Firm has more than 50% owner finance, defined as above
Maj. of Equity	Firm has more than 50% equity finance, defined as above
Age	Age, logarithm of the number of years from foundation
Size	Log of (Number of employees + 1)
R&D Exp.	R&D Expenditures/Turnover, one year lag, 0.01 winsorised.
Profit margin	Profits on Turnover, winsorised fraction 0.05
Public Support	Dummy equal one if the firm received public support (loans and subsidies)
Product Innovation	Dummy equal one if the firm introduced a new product in reference year
Process Innovation	Dummy equal one if the firm introduced a new process in reference year
Founder Human Capital	Dummy equal one if the founder has a degree
Firm Human Capital	Number of employees with a degree on number of total employees, logarithm
Year dummies	Dummies controlling for yearly effect, omitted
Sector dummies	Sectoral dummies (manufacturing, services, software, construction, and wholesale and retail markets), omitted

Table 1 Variable Description

Industrial sectors			
	Industrial sector (last codification, WZ2008)	Frequency	Percent
Cutting-hedge tech. manuf.	20.20, 21.10, 21,20, 24.46, 25.40, 26.11, 26.20, 26.30, 26.40, 26.51, 26.60, 30.30, 30.40, 32,50	723	8.81
High tech. Manufacturing	20.13, 20.14, 20.16, 20.17, 20.41, 20.51, 20.53, 20.59, 22.11, 22.19, 23.19, 26.70, 27.11, 27.12, 27.20, 27.40, 27.90, 28.11-15, 28.23, 28.24, 28.29, 28.30, 28.41, 28.49, 28.92–96, 28.99, 29.10, 29.31, 29.32, 30.20	585	7.13
Technology intensive sectors	61.1–3, 62 (without 62.01), 63.1, 71.1–2, 72.1	1808	22.03
Software	62.01	735	8.96
Non-high-tech manufacturing	10–33	1034	12.60
Skill intensive services	69.1–2, 70.2, 72.2, 73.1–2	613	7.47
Other business orientated services	49.2, 49.5, 50.2, 50.4, 51.2, 52, 53, 61.9, 63.9, 64, 74.1, 74.3, 74.9, 77.1, 77.3–4, 78, 80–82,	537	6.54
Consumer orientated services	49.1, 49.3–4, 50.1, 50.3, 51.1, 55, 56, 58–60, 65–66, 68, 74.2, 77.2, 79, 85.5-6, 90–93, 95–96	839	10.22
Construction	41–43	868	10.58
Wholesale and retail market	45–47 (without 46.1)	993	12.10
Subtotal		8206	106.45
Firms for which the sector is missing		67	
Grand Total		8273	

Table 2. Industry distribution of the sample analysed. Several firms change sectors during the panel and this causes the cumulative percentage to be more than one hundred.

Descriptive Statistics						
Variables	Mean	Standard Dev.	Min	Max	Median	N
Owner finance	.27	.44	0	1	0	16,158
Equity Finance	.02	.14	0	1	0	16,158
Debt Finance	.22	.41	0	1	0	16,158
Maj. of Owner Finance	.90	.30	0	1	0	16,158
Maj. of Equity	.01	.09	0	1	0	16,158
Maj. of Debt	.13	.34	0	1	0	16,158
Age	.93	.62	0	2.07	1.09	16,158
Size	.62	.70	0	1.79	0	16,158
R&D Exp/Turnover.	6	.22	0	1.67	0	16,158
Profit margin	.14	.23	-0.5	0.625	0.10	16,158
Public Support	.26	.44	0	1	0	16,158
Product Innovation	.32	.47	0	1	0	16,158
Process Innovation	.20	.39	0	1	0	16,158
Founder Human Capital	.45	.50	0	1	0	16,158
Firm Human Capital	.36	.67	0	3.40	0.69	16,158

Table 3. This table shows descriptive statistics for the variables included in the regressions. Medians are not shown for dummy variables**.**

Correlations Table									
		(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
Type of finance	**(1) Internal**								
	(2) Owner	-0.014*							
	(3) Equity	-0.034***	0.160***						
	(4) Debt	0.021***	0.430***	0.12***					
Majority of	**(5) Internal**								
	(6) Owner					-0.074***			
	(7) Equity					-0.058***	-0.034***		
	(8) Debt					-0.140***	-0.130***	-0.028***	
	(9) Age	0.019**	0.004	0.011*	0.074***	0.077***	0.004	0.016**	0.060***
	(10) Size	0.094***	0.012*	0.100***	0.140***	0.057***	-0.058***	0.083***	0.140***
	(11) Profit margin	0.130***	-0.200***	-0.170***	-0.120***	0.180***	-0.120***	-0.140***	-0.066***
	(12) Public Support	0.053***	0.120***	0.075***	0.210***	-0.023***	-0.009	0.051***	0.180***
Innovation	**(13) R&D Exp**	-0.050***	0.160***	0.260***	0.013*	-0.075***	0.120***	0.280***	-0.021**
	(14) Product	0.091***	0.085***	0.072***	0.055***	0.064***	0.050***	0.040***	0.033***
	(15) Process	0.110***	0.068***	0.055***	0.058***	0.077***	0.044***	0.032***	0.039***
	(16) Founder Human Capital	-0.0048	0.010*	0.006	0.014**	-0.007	0.003	0.0050	0.012*
	(17) Firm Human Capital	0.071***	0.026***	0.160***	0.033***	0.065***	-0.001	0.150***	0.019**

Table 4. This table shows the pairwise correlations between all the variables included, with the relative significance level. Correlations between dependent variables are omitted.

	Correlation Table (continued)									
		(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
	(9) Age									
	(10) Size	0.160***								
	(11) Profit margin	0.150***	-0.190***							
	(12) Public Support	-0.290***	0.140***	-0.140***						
	(13) R&D Exp	-0.070***	0.024***	-0.320***	0.072***					
Innovation	**(14) Product**	-0.098***	0.100***	-0.120***	0.087***	0.190***				
	(15) Process	-0.077***	0.092***	-0.041***	0.088***	0.130***	0.310***			
	(16) Founder Human Capital	-0.005	0.012*	-0.0082	0.007	0.017*	0.012	0.001		
	(17) Firm Human Capital	0.160***	0.410***	-0.150***	0.036***	0.190***	0.160***	0.120***	0.020***	

Classes implemented for ordered Logit estimation.

(1) These classes include owner finance, family funds, government finance, equity and debt.			(2) These classes include family funds, government finance, equity and debt.		
5 Classes	**Freq./ Firms**		**4 Classes**	**Freq./Firms**	
1	3640/2666	Only owner funds.	**1**	394/340	Family and relatives' funds, but no others.
2	394/340	Funds from friends and family, but neither gov. funds, equity or debt	**2**	294/275	Government funds, but neither debt or equity
3	294/275	Gov. funds, but no equity nor debt	**3**	317/220	Equity, but not debt
4	317/220	Equity, but not debt	**4**	6093/3523	Debt
5	6093/3523	Debt only			
Tot	10738		**Tot**	7098/4358	
7 Classes			**7 Classes**		
1	3640/2666	Only owner funds	**1**	394/340	Only family and relatives' funds
2	554/480	Owner funds and, family or relative funds or gov. funds, no debt or equity	**2**	235/220	Only government finance
3	134/129	Family or relatives or gov. funds, but no other finance.	**3**	59/58	Gov. funds and family and relatives' funds, but no equity nor debt
4	7/6	Equity, and family or relatives or gov. funds, but no other	**4**	31/31	Equity and family or relatives', but no debt and no government funds.
5	85/67	Only equity, but no other	**5**	18/13	Equity and gov. funds, but no debt nor family funds.
6	309/248	Equity and debt	**6**	309/248	Equity and debt
7	5784/3418	Debt	**7**	57843418	Debt
Tot	10513		**Tot**	6830	

Table 5. This table shows the composition of the classes used in the ordered Logit. In order to test for the possible different combinations of finance, we define two different classes for two different specifications, with and without owner finance. Due to the panel structure of the database, the frequencies are higher of the number of firms, since some firms repeatedly receive a specific type of finance.

Classes Composition: Owner fin., fam. funds, gov. fund, equity and debt.				
	(1)	**(2)**	**(3)**	**(4)**
Dependent Variable	**5 Classes**	**5 Classes**	**7 Classes**	**7 Classes**
Age	2.240***	2.633***	2.156***	2.445***
	(0.338)	(0.500)	(0.314)	(0.442)
Size	2.646***	2.834***	2.337***	2.528***
	(0.222)	(0.335)	(0.186)	(0.281)
Profit Margin	1.362*	1.870**	1.662***	2.236***
	(0.250)	(0.504)	(0.299)	(0.583)
Public support	2.787***	3.059***	2.619***	2.714***
	(0.303)	(0.465)	(0.275)	(0.390)
R&D Exp.		0.362***		0.334***
		(0.076)		(0.070)
Product Innovation		0.982		0.967
		(0.130)		(0.124)
Process Innovation		1.082		1.088
		(0.167)		(0.161)
Founder Human Capital		0.997		0.993
		(0.128)		(0.122)
Firm Human Capital		0.857		0.811**
		(0.093)		(0.084)
Sector dummies	***	***	***	***
Time dummies	***	*	***	*
Owner | FFF, No other	1.971***	0.295		
	(0.217)	(0.302)		
FFF, No other | Gov. Funds, No Eq. No Debt	2.327***	0.737**		
	(0.220)	(0.303)		
Gov. Funds, No Eq. No Debt | Eq. No Debt.	2.479***	0.857***		
	(0.221)	(0.303)		
Eq. No Debt. | Debt	2.658***	1.061***		
	(0.223)	(0.174)		
Own | Own and family or Gov., no debt, no eq.			1.892***	2.686***
			(0.209)	(0.216)
Own and family or Gov., no debt, no eq. | Family or Gov., no others			2.276***	2.686***
			(0.212)	(0.216)
Family or Gov., no others | Equity and family or Gov., no others			2.394***	2.686***
			(0.213)	(0.216)
Equity and family or Gov., no others | Only Eq.			2.401***	2.686***
			(0.213)	(0.216)
Only Eq. | Eq. and Debt.			2.451***	0.828***
			(0.214)	(0.290)
Eq. and Debt. | Debt			2.686***	1.082***
			(0.216)	(0.291)
Random Effects Constant	4.730***	5.844***	4.417***	5.275***
	(0.546)	(0.862)	(0.509)	(0.775)
N	5,353	3,764	5,273	3,705

Table 6. This table shows the ordered Logit regression for the classes specified in Table 5, column 1. Clustered standard errors are in parentheses. Odds ratios are reported. For time and sector dummies the joint statistical significance is shown. Significance levels: *** p<0.01; ** p<0.5 *p<0.1

Classes composition: Family funds, gov. funds, equity and debt				
	(5)	(6)	(7)	(8)
Dependent Variable	**4 Classes**	**4 Classes**	**7 Classes**	**7 Classes**
Age	2.472***	2.641***	2.061***	1.941**
	(0.684)	(0.867)	(0.474)	(0.513)
Size	2.710***	3.690***	1.912***	2.310***
	(0.423)	(0.801)	(0.237)	(0.374)
Profit Margin	3.252***	1.779	4.232***	2.941***
	(1.110)	(0.822)	(1.272)	(1.172)
Public support	1.085	1.664**	1.099	1.398*
	(0.207)	(0.407)	(0.178)	(0.279)
R&D Exp.		0.180***		0.255***
		(0.062)		(0.076)
Product Innovation		0.756		0.820
		(0.170)		(0.155)
Process Innovation		1.211		1.096
		(0.325)		(0.239)
Founder Human Capital		1.023		0.984
		(0.225)		(0.179)
Firm Human Capital		0.662**		0.674***
		(0.122)		(0.101)
Sector dummies	**		**	
Time dummies	***	*	*	
Family only | Gov., no Debt, No Eq.	-3.926***	-2.836***		
	(0.541)	(0.599)		
Gov., no Debt, No Eq.| Eq., No debt	-3.255***	-2.385***		
	(0.515)	(0.581)		
Eq., No debt | Debt	-2.615***	-1.729***		
	(0.491)	(0.558)		
Only Family | Only Gov.			-3.248***	-2.731***
			(0.421)	(0.490)
Only Gov. | Gov. and Fam., no Debt nor Eq.			-2.726***	-2.360***
			(0.405)	(0.478)
Gov. and Fam., no Debt nor Eq. | Eq. and Fam., no Gov. nor Debt.			-2.655***	-2.319***
			(0.403)	(0.477)
Eq. and Family, no Gov. nor Debt. | Eq. and Gov.			-2.613***	-2.275***
			(0.401)	(0.475)
Eq. and Gov. | Equity and Debt			-2.571***	-2.231***
			(0.400)	(0.474)
Equity and Debt | Debt			-1.874***	-1.547***
			(0.382)	(0.454)
Random Effects Constant	8.339***	7.567***	5.255***	4.690***
	(1.909)	(2.167)	(1.144)	(1.306)
N	3657	2768	3555	2695

Table 7. This table shows the ordered Logit regression for the classes specified in Table 5, column 2. Clustered standard errors are in parentheses. Odds ratios are reported. For time and sector dummies the joint statistical significance is shown. Significance levels: *** p<0.01; ** p<0.5 *p<0.1

	(1)	(2)	(3)	(4)	(5)	(6)
Type of finance	**Owner**	**Owner**	**Equity**	**Equity**	**Debt**	**Debt**
Age	0.657***	0.736***	1.004	1.069	1.160*	1.304***
	(0.050)	(0.065)	(0.240)	(0.299)	(0.100)	(0.129)
Size	0.929*	0.874***	2.426***	1.682***	1.645***	1.549***
	(0.037)	(0.045)	(0.293)	(0.275)	(0.074)	(0.087)
Profit Margin	0.169***	0.158***	0.013***	0.044***	0.325***	0.323***
	(0.017)	(0.021)	(0.004)	(0.020)	(0.039)	(0.050)
Public support	1.349***	1.507***	1.847***	2.073***	2.247***	2.432***
	(0.076)	(0.108)	(0.307)	(0.421)	(0.139)	(0.185)
R&D Exp.		2.285***		3.647***		0.678**
		(0.288)		(0.868)		(0.104)
Product Innovation		1.311***		1.456*		1.241***
		(0.085)		(0.290)		(0.089)
Process Innovation		1.313***		1.172		1.322***
		(0.099)		(0.253)		(0.110)
Founder Human Capital		1.082		1.339		1.094
		(0.065)		(0.256)		(0.073)
Firm Human Capital		0.997		1.507***		0.927
		(0.052)		(0.204)		(0.053)
Sector dummies		***	***		***	***
Time dummies	***	***			***	***
Random effects						
Log of Variance	0.446***	0.514***	1.149***	1.085***	0.797***	0.875***
	(0.078)	(0.093)	(0.210)	(0.253)	(0.074)	(0.086)
N	15,197	11,772	15,197	11,772	15,197	11,772

Table 8. Panel Logit estimates for the probability of obtaining any amount of a specific type of finance. Clustered standard errors are in parentheses. Odds ratios are reported. For time and sector dummies the joint statistical significance is shown. The constant is included in the model, but not reported. Significance levels: *** p<0.01; ** p<0.5 *p<0.1.

	(1)	(2)	(3)	(4)	(5)	(6)
Majority of:	**Owner**	**Owner**	**Equity**	**Equity**	**Debt**	**Debt**
Age	0.589***	0.642***	1.400	1.935	1.045	1.058
	(0.051)	(0.064)	(0.576)	(1.064)	(0.121)	(0.140)
Size	0.704***	0.680***	2.754***	1.378	1.748***	1.923***
	(0.033)	(0.040)	(0.566)	(0.454)	(0.104)	(0.144)
Profit Margin	0.270***	0.231***	0.003***	0.037***	0.979	1.214
	(0.030)	(0.034)	(0.002)	(0.031)	(0.162)	(0.266)
Public support	0.761***	0.757***	1.861**	2.227**	3.037***	3.449***
	(0.051)	(0.067)	(0.518)	(0.843)	(0.250)	(0.344)
R&D Exp.		1.781***		8.848***		0.617**
		(0.227)		(3.845)		(0.146)
Product Innovation		1.289***		0.983		1.212*
		(0.097)		(0.360)		(0.122)
Process Innovation		1.203**		1.412		1.282**
		(0.105)		(0.544)		(0.146)
Founder Human Capital		1.037		1.622		0.954
		(0.071)		(0.579)		(0.087)
Firm Human Capital		1.073		2.068***		0.758***
		(0.064)		(0.537)		(0.059)
Sector dummies			***		***	**
Time dummies	***	*	***	**		
Random effects						
Log of Variance	0.412***	0.383***	1.356***	1.487***	0.571***	0.624***
	(0.097)	(0.123)	(0.346)	(0.446)	(0.118)	(0.138)
N	15,197	11,772	15,197	11,772	15,197	11,772

Table 9. Panel Logit estimates for the probability of obtaining more than 50% of a specific type of finance. Clustered standard errors are in parentheses. Odds ratios are reported. For time and sector dummies the joint statistical significance is shown. The constant is included in the model, but not reported. Significance levels: *** p<0.01; ** p<0.5 *p<0.1.

	(1)	(2)
	Debt	**Other**
Age	-0.398	-0.404
	(0.577)	(0.532)
Size	-0.210	0.493
	(0.355)	(0.332)
Profit Margin	1.836*	2.410**
	(1.083)	(1.011)
Public support	0.178	0.594
	(0.414)	(0.380)
R&D Exp.	-1.216***	-2.306***
	(0.470)	(0.431)
Product Innovation	0.280	0.177
	(0.362)	(0.314)
Process Innovation	-0.071	-0.057
	(0.424)	(0.398)
Founder Human Capital	-0.390	-0.363
	(0.365)	(0.339)
Firm Human Capital	-0.929***	-0.861***
	(0.272)	(0.241)
Sector dummies	**	
Time dummies	**	
Constant	2.468**	4.132***
	(0.973)	(0.913)
N	1684	
Pseudo R-squared	0.207	

Table 10 Multinomial Logit Regression. The categorical variable has a value of 1 if a firm is financed by more than 50% in a given year by other sources (family and friends, government funds, other funds), a value of 2 if the majority of fund comes from short- or long-term debt and a value of 3 if the majority of funds is from equity or mezzanine funds. The latter is the base alternative; This means that, for instance, firms that firms that performed R&D expenses in the previous year are less likely to use debt than firms that did not, compared to using equity. Clustered standard errors are in parentheses. For time and sector dummies the joint statistical significance is shown. Significance levels: *** p<0.01; ** p<0.5 *p<0.1