How to secure an innovation grant for firms in new industries? Gender and resource perspectives

Article

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Abstract

Purpose

Research on financing for entrepreneurship has consolidated over the last decade. However, one question remains unanswered: how does the combination of external finance, such as equity and debt capital and internal finance, such as working capital, affect the likelihood of grant funding over time?

Th purpose of this study is to analyse the relationship between different sources of financing and firms' ability to fundraise via innovation grants, and to examine the role of female CEO in this relationship. This is a new and novel focus of analysis, compared to equity and debt fundraising as innovation grants manifest as recognition of innovation and its commercialization, and may be industry and product-specific.

Design/Methodology/Approach

We use firm-level financial data for 3,034 high-growth firms observed in 2015, 2017 and 2019 across 35 emerging sectors in the United Kingdom (UK) to test the factors affecting the propensity of high-growth firms to secure an innovation grant as a main source of fundraising for innovation during the early stages of product commercialization.

Findings

The results do not confirm gender bias for innovation fundraising in new industries. This contrasts with prior research in the field which has demonstrated that access to finance is gender-biased. However, the role of CEO gender is important as it moderates the relationship between the sources of funding and the likelihood of accessing the grant funding.

Research limitations/implications

This study does not analyse psychological or neurological factors that could determine the intrinsic qualities of male and female CEOs when making high-risk decisions under conditions of uncertainty related to innovation. Direct gender bias with regards to access to innovation grants could not be assumed. This study offers important policy implications, and explains how firms in new industries can increase their likelihood of accessing a grant and how CEO gender can moderate the relationship between availability of internal and external funding and securing a new grant.

Social implications

This study implicates and empirically demonstrates that gender bias does not apply in fundraising for innovation in new industries. As female CEOs represent various firms in different sectors, this may be an important signal for investors in new product development and innovation policies targeting gender bias and inclusion.

Originality/value

We draw on female entrepreneurship and feminist literature to demonstrate how various sources of financing and gender change the likelihood of grant funding in both the short- and long-run. This is the first empirical study which aims to explain how various internal and external sources of finance change the propensity of securing an innovation grant in new industries.

Keywords: innovation, working capital, debt financing, equity financing
JEL: F23, L25, J16, O17

1. Introduction

Given the market vulnerability of firms in new industries, such as artificial intelligence, augmented reality, drones, health informatics, fast fashion, and others, obtaining access to appropriate forms of finance can be challenging (Cowling et al., 2012; Chowdhury et al., 2019; Audretsch et al., 2022) and may experience gender bias (Thursby and Thursby, 2005; Alsos, Hytti and Ljunggren, 2013; Roberts, 2015). This is due to the general perception that women are less innovative than men (Nählinder, 2010; Kim and Starks, 2016), and also more risk-averse than men (Eddleston et al., 2016; Cowling et al., 2020), which has led to the disadvantageous position of women entrepreneurs (Brush, Edelman, Manolova and Welter, 2019). The seminal work of Morsy (2020) argues that gender gaps in access to finance prevail in the vast majority of countries, including developed and developing countries.

A well-rehearsed debate (Cowling et al., 2020) suggests female CEO are disadvantaged in financing for entrepreneurship, affecting both the demand and supply of equity, debt, and other non-equity financing (Coleman and Robb 2009; Brush et al., 2006, 2012). We add a new dimension to this debate by critically analyzing the relationship between different sources of financing and firms' ability to fundraise via innovation grants. This is a new and different focus of analysis compared to equity and debt fundraising, as innovation grants manifest as recognition of innovation and its commercialization and may be industry and product-specific (Howell, 2017; Mazzucato and Semieniuk, 2017).

While prior research mainly focused on the role of debt and equity financing for innovation in women-led firms, there is a paucity of research into the factors which facilitate or impede grant fundraising, as well as how grant fundraising could complement or substitute the availability of various sources of internal and external financing. Fundraising for innovation via grants has remained an attractive source of external financing for innovation, and its resource combinations and gender aspects are under-researched (Howell, 2017; Mazzucato and Semieniuk, 2017).

While prior research has identified a gender gap in fundraising for innovation (Audretsch, Belitski and Brush, 2022), the empirical evidence of a gender gap in financing entrepreneurship in new sectors is limited. Some empirical evidence suggests there is no gender gap in fundraising for innovation. For example, the Beauhurst data, which was collected using machine learning during 2015–2020 for 3,034 companies in the new industries in the United Kingdom (UK), found no differences in the likelihood of innovation between women and men-led firms. Interestingly, 19 women-led firms and 18 men-led firms out of every 100 firms received an innovation grant (Beauhurst, 2020).

By contrast, recent research in the United States has demonstrated that Phase II Small Business Innovation Research (SBIR) research-funded projects had a greater probability of being commercialized in women- than in men-owned and -led firms (Bednar et al., 2019).

Despite this surprising empirical fact, there is a paucity of knowledge about who participates in innovation and how successful they are (Turner, 2009; Carrasco, 2014; Dohse, Goel and Nelson, 2019; Wellalage, Fernandez and Thrikawala, 2020), rather than where and how innovation happens (Audretsch and Belitski, 2020a, 2020b). Research on women entrepreneurship has become more prominent in recent years (Brush et al., 2019; Ladge, Eddleston and Sugiyama, 2019) and has found significant differences in access to financial resources for innovation (Jennings and Brush 2013; Balachandra, Briggs, Eddleston and Brush, 2019; Christofi et al., 2019).

Similar research in the entrepreneurship literature has also shifted its focus on the intersection of innovation, entrepreneurship, financing, and gender (Brush, Carter, Gatewood, Greene and Hart, 2006; Brush, De Bruin and Welter, 2009; Ladge et al., 2019).

There are several gaps in the literature on gender differences in innovation. These include an explanation of why women are less visible as inventors, innovators, and entrepreneurs than men, and the conditions that lead women to take innovation risks and increase survival and growth rates (Alsos, Isaksen and Ljunggren, 2006; Gicheva and Link, 2015) with the few exceptions (Hadjielias, Christofi and Tarba, 2022).

The most important drivers of innovation in women-led firms are the role of family support, the appropriability of knowledge, access to external financing, and networks (Brush, Greene, Balachandra, and Davis, 2014). However, there is a lack of evidence about who drives innovation through various internal and external sources of finance.

The evidence on women-led innovation remains mixed (Alatas, Cameron, Chaudhuri, Erkal and Gangadharan, 2009), particularly in the new industries (e.g. precision medicine, chatbots, metamaterials, wearables, big data, the internet of Things (IoT), artificial intelligence, drones and robotics, and others).

The purpose of this study is to address this gap by investigating how female CEOs use internal and external resources and develop innovative strategies to enact innovation and increase the propensity of the innovation grant award. This paper draws on three main theoretical arguments that explain gender differences in innovation: (i) access to finance; (ii) risk aversion; and (iii) the appropriability of innovation.

Unlike prior research, which typically resorts to cross-sectional data (Carrasco, 2014; Balachandra et al., 2019; World Bank, 2019) and averaged country-level analysis (Verheul, van Stel and Thurik, 2006), we advance women entrepreneurship research by using data from 3,034 of the most innovative firms in 35 new industries during 2015–2020.

Our findings demonstrate a substantial gender gap in the propensity to receive an innovation grant when firms hold intangible assets and protect their innovations. While we do not find significant differences in access to equity and debt financing between women and men-led firms, an increase in working capital in the long term is conducive to innovation. In contrast, working capital availability may reduce grant application and innovation activity in women-led firms.

This study makes two significant contributions to the innovation and entrepreneurship literature. First, we contribute to the cross-over of knowledge in the relationship between creation and the nature of women related to risk perception, uncertainty, and knowledge appropriability, and how this relationship changes the likelihood of innovation and financing it (De Bruin, Brush and Welter, 2006; Brush et al., 2006). Second, we contribute to the entrepreneurship literature by demonstrating how gender aspects and access to internal and external finance for innovation change a firm's propensity to receive innovation grants in the new industries (Brush et al., 2009; Balachandra et al., 2019). In doing so, we empirically test whether internal working capital, equity, debt financing, and the appropriability mechanisms of innovation, e.g., the intangible assets related to the perception of risk and uncertainty by a woman CEO, explain the innovation activity search for innovation resources in new industries.

The remainder of the paper is organized as follows. The next section discusses the drivers of innovation activity and gender differences. We present our data and method in the third section, followed by a discussion of our results in section four. Our fifth section offers conclusions, policy and managerial implications, and future research directions.

2. Background and hypotheses

Prior research has acknowledged that the preferred innovator profile is gender-biased, with uncertainty, aggression and risk-taking being traits associated with male innovators (Ahl 2006; Jennings and Brush 2013). This means that male CEOs are more likely to raise external funding and develop preferred innovation prototypes (Marlow et al., 2008; Ahl and Marlow, 2012). Prior research has demonstrated that assumptions and perceptions about the risk-taking behaviour of women innovators (Marlow and Swail, 2014) created constraints for the support of women-led ventures and limited access to entrepreneurial capital (Brush et al., 2012, 2019). The legitimacy of women-led innovative firms is limited, and investors often choose to supply entrepreneurial finance to male CEOs as they are believed to have stronger dynamic capabilities (Marlow and Swail, 2014; Marlow and Martinez-Dy, 2018). As a result of potential gender bias in financing innovation (Deloitte, 2016), female CEOs were found to be more likely to lead startups in traditional subsectors with lower productivity rates and service industries (Carter et al., 2015). In the context of external fundraising, attitude to risk and uncertainty are of premier importance given the inherited uncertainty of the innovation process and the outcomes of market commercialization. Consequently, female CEOs have been disadvantaged in terms of external fundraising because their risk-aversion (Ahl, 2006) and risk intolerance prevented risk-taking for innovation; consequently, internal investors and lenders have perceived this behaviour as rejecting risk-taking (Speelman et al., 2013; Morsy, 2020).

Therefore, the choice of finance is often conditional on a lower toleration for risk in terms of financial behaviour, including investment, stock trading, funding (Beckmann and Menkhoff, 2008; Ahl and Marlow, 2012), and firm growth aspirations (Belitski and Desai, 2021).

Not surprisingly, given the higher risk-aversion of female CEOs and the way investors perceive their operating profile, women are more likely to use informal sources of funding. These sources include savings, credit (Roberts 2015), family support, and internal working capital (Lim and Suh 2019; Cowling et al., 2020).

Grant fundraising remains one of the most popular external sources of finance for innovation. The main advantage of innovation grants is that there is no expectation of grant repayment, which makes them an attractive source of external finance. While innovation grants do not require repayment or diluting property, owner-managers will need to engage with external partners and demonstrate innovation effort and prototype, which involves a transaction cost (Choi and Contractor, 2017; Audretsch and Belitski, 2020b). Resource dependency theory helps explain the choice of external funding. As female CEOs respond differently to uncertainty and risk (Ahl and Marlow, 2012; Ngoasong and Kimbu, 2019), their access to external funding for innovation is limited (Brush, 2006; De Bruin et al., 2006; Wellalage et al., 2020). Securing debt financing is preferable for female CEOs as this is perceived as less risky than other sources of finance, particularly equity financing (Becker-Blease and Sohl, 2007).

While women in general would be more risk-averse, bank loans are perceived as less risky to women business owners (Croson and Gneezy, 2009; Carter et al., 2015) as female CEO would prefer debt to equity funding, where the property is diluted, and the control for business becomes more difficult to enforce. Prior research discussed various static lending models that fail to factor in differential contexts shaping loan conditions (Carter et al., 2007; Coleman and Robb 2009; Freel et al., 2012). We recognise the constraints upon debt financing funding and the role of risk and uncertainty in women's decision-making. In the short term, when security is not yet realized, female CEOs will continue to "capital hunt" and aim to attract other resources, including grants, to fund innovation. In the long term, bank loans provide an important form of stability in financing which may reduce the willingness of female CEOs to further "hunt for capital". We hypothesize that an increase in a debt financing will reduce grant fundraising in women-led firms compared to men-led firms in the long term, while securing a bank loan may trigger further searches for complementary funding in the short term. These differences depend upon the feminised risk aversion and gender differences in attitudes to inter-temporal risk and uncertainty (Marlow et al., 2012; Cowling et al., 2012, 2020). We hypothesize:

H1a: In the long term, bank lending will reduce grant fundraising in women-led firms.

H1b: In the short term, bank lending will increase grant fundraising in women-led firms.

Both banks and venture capitalists identify the risk factors that influence the investment or bank lending decision and the share of the equity which investors will demand for their risk-taking (Beck and Demirguc-Kunt, 2006; De Rassenfosse and Fischer, 2016; Han et al., 2017). While Cowling et al. (2020) report that gender discrimination in financial markets should not exist, they also argue that the likelihood of access to external debt and equity financing may differ between male- and female-owned businesses. This is due to the socio-economic context of countries and industries where women do business, as investors may perceive lower levels of collateral and entrepreneurial capital (Marlow and Patton 2005; Coleman and Robb, 2015) with the empirical evidence in Italy (Bellucci et al., 2010) and the United States (Eddleston et al., 2016). The recent study of Alsos and Ljunggren (2017) using the signalling theory has demonstrated that the adoption of 'compensation strategies' in female-led firms when men are involved in the investment and bidding team could increase the likelihood of fundraising.

Investors rely on signals about the quality of entrepreneurs, as well as their ambitions and goals (Nelson, Maxfield and Kolb, 2009; Nelson, 2015), and perceive women business owners and CEOs as having different goals (e.g. non-commercial, societal, environmental, community) resulting in their behaviours being different from men entrepreneurs (Alsos and Ljunggren, 2017). Given less familiarity with women entrepreneurs and the perceived differences in innovation objectives, investors may interpret women-led firms as riskier investments, reducing the likelihood of equity investment (Greene et al., 2001; Brush et al., 2014). The proportion of women receiving venture capital funding therefore is disproportionate to the share of women-led firms (Brush et al., 2006; Audretsch et al., 2022).

Whilst substantive evidence for risk-aversion in women remains limited (Eddleston et al., 2016; Brush et al., 2019), the notion of the risk-aversity of women-led innovative firms is still questionable (Marlow and Swail 2014; Morsy, 2020). Female CEOs who can access equity funding are likely to be considered to be as competent and reliable as male CEOs, and therefore it is likely they will be able to increase their grant fundraising as well. Alsos and Ljunggren's (2017) argument, based on signalling theory, is that the high-quality signals of female-led firms will increase their propensity to access other external finance if they can transmit a signal to investors that their company is of high quality (e.g. patenting, raising other finance, etc.). The strength of the signal dissipates over time, as the strongest signal of high-quality firms is likely to increase other sources of external funding, including grants in the short term. Innovators are required to continuously signal with the market traction and secure various forms of external financing to support the credibility and high-quality perception of their firms, particularly women-led firms. Based on this we hypothesize:

H2a: In the long term, equity capital will reduce grant fundraising in women-led firms.

H2b: In the short term, equity capital will increase grant fundraising in women-led firms.

While gender bias in access to equity and debt financing has been investigated (Cumming et al., 2021; Greene et al., 2001), few studies have examined the relationship between the level of internal working capital and grant fundraising (Coleman and Robb, 2009, 2012). Given the high risk aversion of female entrepreneurs (Marlow et al., 2012; Cowling et al., 2020), we argue that an increase in the availability of internal working capital will disincentivize female CEOs from applying and securing innovation grants. Using working capital for innovation and growth (Belitski and Desai, 2021) could be the preferred strategy in women-led firms, as bank lending and equity financing will lead to ownership dilution and an increase in costs to serve the debt (Beck and Demirguc-Kunt, 2006; De Rassenfosse and Fischer, 2016; Han et al., 2017). Thus, women entrepreneurs who can secure internal working capital perceive it as risk-free and will rely on it in innovation activity, delaying access to innovation finance in the short term as they use working capital instead.

The high risk aversion of women entrepreneurs will reduce their willingness to apply for innovation grants in the short term. As time goes on and internal working capital is used, women entrepreneurs will reconsider accessing grant funding and will be more willing to put up with the transaction costs of the application and apply for an innovation grant. In the short term, working capital is likely to be used to support innovation, invest in R&D, and take out time for developing a prototype.

Our expectations regarding women's preference for using working capital to finance innovation is rooted in the theoretical and empirical evidence that women entrepreneurs are biased towards low-risk funding. Unlike women, men entrepreneurs have an overconfidence bias (Luo et al., 2018), meaning they take greater risks (Ahl and Marlow, 2012; Balachandra et al., 2019) and will be more willing to access external funding independently of the amount of working capital available (Puri and Robinson, 2007). As time goes on and the internal working capital is exhausted, women entrepreneurs will start to diversify the risks by putting up external funding applications, with innovation grants given the first preference unlike equity or debt financing. Thus, an increase in past levels of working capital is positively associated with grant fundraising as women diversify their funding strategies (Palvia, Vähämaa and Vähämaa, 2015).

We suggest that this association between the inter-temporal availability of working capital and the risk-aversity of women entrepreneurs is complex (Marlow and Swail, 2014; Palvia et al., 2015), but could be used as a vehicle to explain differences in risk perception and risk-taking behaviour between male and female CEOs (Saridakis, Marlow, and Storey, 2013). Based on the discussion above, we posit that the availability of working capital in women-led firms will reduce grant fundraising in the short term. In the long run, female CEOs will realize that working capital may run out and will resume their search for additional external sources. A long-term effect which is associated with past levels of working capital availability could be viewed as a signal of potential resource limitation, which increases grant applications and fundraising in women-led firms.

H3a: In the long term, working capital will increase grant fundraising in women-led firms.

H3b: In the short term, working capital will reduce grant fundraising in women-led firms.

Our conceptual model is illustrated in Figure 1.

INSERT FIGURE 1 ABOUT HERE

3. **Data and Method**

Sample

Most datasets represent a static combination of resources at one point in time, as conducting longitudinal surveys for a potential dynamic analysis is even more costly and time-intensive. Self-reported data from firms is likely to be more biased (Gonzalez, Lopez-Cordova and Valladares, 2007) than the objective data, especially if many managers in growing firms are unable to gather a sufficient amount of data on markets, customers, and competitors, or underreport data for accounting reasons.

The UK-based data agency Beauhurst collects firm-level data using the inclusion criteria and tracking live all high-growth firms in the UK. We obtained data on all high-growth firms in the UK which were tracked for the last 10 years through a commercial agreement with the data provider Beauhurst. However, in order to be able to track the same firms over a certain period of time, we chose the period which maximizes the number of firms: 2015–2020. We performed our analysis using three cross-sectional datasets for the same 2683 firms observed in 2015, 2017, and 2019 (Beauhurst, 2020).

The Beauhurst datasets were collected using open data on each company, such as websites, social media, news, and annual financial reports. All firms officially registered in the territory of the UK and which comply with at least one inclusion criteria will be tracked and included in this dataset. These criteria are as follows: 1) received equity or debt fundraisings for innovation and

R&D over the last year; 2) firms that are spinouts from a university or industry; 3) firms that have completed one of the UK's top business accelerator programs; 4) firms which completed a management buy-in/buy out or were acquired; 5) firms which received an innovation grant from the Innovate U.K. or other public program supporting innovation; 6) firms which demonstrated at least 10% annual turnover growth over the last three years (scaleup). Finally, firms which are part of the so-called UK's top high-growth lists (e.g. being on the Fast Track 100 or Technology Fast 50 indicates that a company is growing quickly and is gaining visibility) within the Beauhurst dataset were also included. Non-commercial entities (e.g. universities, non-for-profits, charities) are not part of this data. Any firm in an emerging industry which applied for and received a grant in the UK during 2015–2020 will be part of this dataset.

The data was collected in March 2020 and covers the period January 2015 to March 2020, just before the COVID-19 pandemic (Belitski et al., 2022).

Our dependent variable—the number of innovation grants received—is limited to the financial year 2019/2020, and is taken in logarithm. To avoid two-way causality, we used our dependent variable for the year 2020 and our explanatory and control variables are one- (2019), three- (2017), and five-year (2015) lagged accordingly. This dynamic picture enables us to demonstrate the intertemporal effects between debt, equity and working capital financing, and we used the past values to predict the likelihood of access to grants in 2020.

We cleaned the data for outliers and used the maximum number of observations available for the non-missing firm owner and CEO values to identify the gender. Each woman owner and CEO was checked for validity using their LinkedIn and Facebook accounts. We have not replaced all non-applicable and missing values with zeroes in order to avoid measurement errors and selection bias. The number of observations does not vary between years, and remains at

2683 firms. This means that we could consistently analyze the changes in the independent characteristics in their propensity to affect the outcome (dependent) variable. Our sample distribution by industry, firm size, growth stage, and region is provided in Table 1.

INSERT TABLE 1 ABOUT HERE

Most of the firms in our sample are from the industry of artificial intelligence (10.24%), alternative finance (4.29%), wearables (4.15%), the Internet of Things (7.36%), cybersecurity (7.47%), e-health (5.43%), augmented reality (5.12%) and virtual reality (6.45%) (see Table 1). Industries that are least present in the sample (<1% for each sector) are social shopping, cryptocurrencies, meta-materials, preventive care, and retail biometrics.

The firm size split in the sample is 23.73% microfirms (1–9 full time employees (FTEs)), 33.25% small firms (10–49 FTEs); 16.38% medium firms (50–99 FTEs), 16.32% medium–large firms (100–249) FTEs and 10.34% large firms (250 or more FTEs). Table 1 provides the split between firms led by a female CEO and their total percentages by industry.

Innovative firms are distributed across five distinct growth states (Belitski and Desai, 2021). Most firms are at the venture stage (32.50%), followed by the established stage (21.77%) and the growth stage (17.82%). Firms at the seed stage account for 14.80% of the sample, while firms at the pre-exit stage are 11.03% of the sample. Dormant firms are 2.09% of the sample.

Most of the innovative firms in our sample come from London (36.79%), South East England (12.60%), North West England (8.65%), and East England (Cambridge area) (7.90%). The representation of firms from South and West Scotland, Tayside, and North England is less than 2% for each region.

Dependent variable

Our dependent variable is grant financing, which is measured as 1 plus the number of grants received by a firm in 2019-2020 from the UK Research and Innovation funding agency and other innovation agencies taken in logarithms. The UK Research and Innovation funding agency account for more than 80% of fundraising in the UK, and aims to support innovation in the UK and encourage businesses and universities to work with other commercial and research organizations. The UK Research and Innovation funding agency Innovate UK requires that businesses lead projects. Other types of organizations can apply in collaboration with a business partner.

The funding rates depend on the size and type of organization, and their role in the project. Organizations fall into three categories: businesses, research organizations, and public sector organizations. Innovate UK supports the following R&D categories: fundamental research, feasibility studies, industrial research, and experimental development. In particular, 'experimental development' means acquiring, combining, shaping, and using existing scientific, technological, business, and other relevant knowledge and skills to develop new or improved products, processes, or services.

Innovate U.K. funding can be made available for companies that comply with the following eligibility criteria (Innovate UK, 2020): 1) a firm must be a UK registered business of any size and industry; 2) a firm can be a research and technology organization (RTO) and lead a capital infrastructure project; 3) a firm must research the area of industrial strategy priority for the UK (Industrial strategy, 2020); 4) a first market test of the product has been carried out.

Up to 5 independent assessors assess grant applications. The assessors are experts from both business and academia, and are allocated based on their skills and expertise in the area relevant to the project. The final recommended panel is presented to the Funder's Panel of Innovate U.K. to obtain final approval. The entire preparation process for the application, filing innovation, demonstrations, assessment, and finalization may take between 1 and 2 years.

Grants from Innovate UK are intended to sponsor knowledge creation and transfer, including the commercialisation of new product within 3 to 5 calendar years after secured a grant.

Firms reporting missing values for the innovation grant were excluded from the sample.

Key explanatory variables

We use the following explanatory variables to measure how internal and external financial resources are used for innovation, drawing on prior research (Brush et al., 2012; 2019; Alsos, Hytti, and Ljunggren, 2013; Roberts, 2015; Morsy, 2020; Cowling et al., 2020). We use the total amount of bank funding (pounds sterling) in logarithms, the total amount of working capital (pounds sterling) in logarithms, and the total amount of equity funding (pounds sterling) in logarithms. All explanatory variables were incorporated from the Beauhurst data annual year firm reports and fundraising events that these firms participated in during 2015–2020. We use a binary variable "Female CEO" if a CEO is a female (1 = yes; 0 = no) (Audretsch et al., 2022).

Control variables

First, we use the total intangible assets (pounds sterling) in logarithms as a proxy for the level of intellectual property (Hall et al., 2013). Second, we use firm age and size, as older firms are more likely to accumulate financial capital and use various sources of financing. We used a set of binary variables associated with the firm growth stages: seed stage, venture stage, established stage, growth stage, and exit, with dormant firms as a reference category.

Third, to control for the firm's experience in raising equity funding in the past, we use a proxy number of equity funding rounds. Fourth, we control for additional financial and mentoring support via a binary variable which equals one if a firm participated in public or private accelerator programs aimed at product development and fundraising, and zero otherwise. University and corporate incubators are conduits for resources to generate innovations and promote new industries and markets with commercial relevance (Kolympiris and Klein, 2017).

Finally, we control for the level of digitalization of firms (Cumming et al., 2021; Audretsch and Belitski, 2021) by adding a set of binary variables if a firm has Twitter, Instagram, Pinterest and LinkedIn accounts and uses them for business purposes.

Finally, we use 34 fixed effects industry variables, represented in our sample with other manufacturing and materials, graphene, and 3D printing sectors as reference categories (mainly due to the number of observations). We include 16 regional fixed effects where firms are located (West Scotland is a reference category). We do not use time-fixed effects as we estimate three cross-sectional models for the 2015, 2017, and 2019 periods. The summary statistics and the detailed description of variables used in our model are in Table 2, while the correlation matrix of variables is in Table 3.

INSERT TABLE 2 AND 3 ABOUT HERE

Estimation strategy

We employed a generalised least squared multiple regression model with robust standard errors of our analysis. The choice of model was motivated by the cross-sectional nature of our data (Wooldridge, 2009). Our dependent variable is the number of grants received from the UK

Research and Innovation funding agency y_i taken in logarithms. The number of innovation grants is a continuous variable available for the years 2019-2020, and taken in logarithms:

$$y_{it} = \beta_0 + \beta_{1i}x_{it-k} + \lambda_1 S_{it-k} + \delta_i + \omega_r + u_{it} \quad (1)$$

S_{it-k} is a vector control variable for firm I at time t-k for years 2019, 2017 and 2015; x_{it-k} is a vector of the explanatory variables of firm i in years for years 2019, 2017, and 2015 (equity, bank lending, working capital, female CEO). K is a number of years. Vectors δ_i, ω_r are industry and region fixed effects. A bootstrapping of errors was also applied along with OLS, which led to similar results in terms of the sign and significance of all confidents, but of a different size.

As additional tests we checked for potential multicollinearity issues for all variables by examining the variance inflation factors for all variables, finding each less than 10. We also analysed the correlation coefficients, ensuring that no coefficients were greater than 0.70. We analysed all the variables' histograms, and found the errors were identically and independently distributed with constant variance.

4. **Results**

Results related to our hypothesis are reported in Table 4.

INSERT TABLE 4 ABOUT HERE

Our H1a, which states that bank lending will reduce grant fundraising in women-led firms in the long term, is supported (β=-0.028; p<0.05) (spec. 7, Table 4). The direct effect of bank lending on grant fundraising was positive and significant during 2015–2019 (β=0.003-0.005; p<0.05) (spec. 1-7, Table 4). In the long term, securing a bank loan provides greater financial security and time to use the funding for innovation, reducing grant applications and the need for external capital. Figure 1B for 2015–2019 illustrates the predictive margins for the expected value of grant fundraising given an increase in bank lending between women- and men-led firms. As bank lending increased in 2015 and 2019, there is a reduction in the grant fundraising for women-led firms.

The high level of risk-aversion of women entrepreneurs (Cowling et al., 2020) and culture of working in a "man's world" (McAdam, 2013; Henry, Foss, and Ahl, 2016; Balachandra et al., 2019) may reduce the willingness of female CEOs to apply for a grant. Our H1b, which states that an increase in bank lending will increase grant fundraising in women-led firms in the short-term, is not supported as we find significant and negative coefficients (β=0.029; $p<0.05$) (spec. 3, Table 4). Securing a bank loan will provide a firm with the cash needed to innovate and reduces women willingness to apply for an innovation grant to a greater extent than men-led firms

An increase in equity financing is not associated with an increase in grant fundraising in women-led firms as the coefficients are insignificant. Our H2a and H2b are not supported (spec. 3-7, Table 4). Figures 2B for 2015 and 2019 diagrammatically illustrate the predictive margins of the effect where the confidence intervals overlap.

While one might expect that the gender gap would affect perceptions regarding the level of risk of women entrepreneurs, increasing the uncertainty of decision-making, this argument does not hold for new industries which use new technologies and innovation. Our results extend the prior research of Brush (2006) and Balachandra et al. (2019) on resource constraints, as well as McAdam (2013) on investors' perceptions of masculine-type firms where woman leadership may become a risk factor for equity investment. We found no differences in equity fundraising and its relationship with grant fundraising. This demonstrates that female CEOs in new industries can send similar signals to investors, and that their fundraising behaviour is not different from that of male CEOs.

Using a firm's working capital allows greater control over financing and the extent of financing innovation, and less external control from venture capital and other investors, minimizing the risk of potential intervention by the third party. Our findings support H3a, which states that in an increase in a working capital has a positive effect on grant fundraising in women-led firms in the long-term, with the coefficient positive and statistically significant ($\beta=0.024$; $p<0.05$) (spec. 7, Table 4). Figure 2C for the year 2015 illustrates an increase in grant fundraising if there has been an increase in the working capital 4-5 years ago (Marlow et al., 2008; Ahl and Marlow, 2012; Marlow and Swail, 2014).

Our finding also supports H3b, which states that an increase in working capital will reduce grant fundraising in women-led firms in the short term ($\beta=-0.001$; $p<0.05$) (spec. 3, Table 4). Figure 2C for 2019 illustrates the short-term negative effects of very high levels of working capital.

Other interesting results include firm-level characteristic changes and their effect on the number of grants received. Firms at the growth and established stage rely less on grant financing and have, on average, fewer grant applications than firms in the early stages of growth or at the decline stage. Interestingly, firm age positively affects grant fundraising, which means more mature firms are more successful at obtaining grants than start-ups. Firms that participated in the accelerator programs have, on average, a higher number of grants secured. Firms that use digital platforms such as Pinterest and Instagram receive fewer grants. Firms that are active on Twitter and LinkedIn have, on average, a higher number of grants received. This finding is intriguing as firms who use Twitter and LinkedIn, which are more commercial-oriented platforms, are more successful in grant fundraising than firms who use Pinterest and Instagram, which are oriented toward retail trade and the promotion of an individual lifestyle. Firms that are women- and men-led are not different in the average number of grants received, contrasting to prior research in women entrepreneurship on access to resources (Jennings and Brush, 2013; Ladge et al., 2019; Balachandra et al., 2019; Christofi et al., 2019).

First, firms who secured a greater amount of bank loans, equity, and working capital have, on average, more grants received. The economic effect is greater for equity capital, which is one of the strongest predictors of grant fundraising. Access to equity funding, whether recently or in the past, increases the likelihood of applying for and securing an innovation grant. We find that women- and men-led firms are equally likely to innovate and secure a grant from the UK Research and Innovation funding agency Innovate UK, given the same access to equity funding (Figure 2B).

Robustness check

It is important to use the model adequacy test to understand the quality of estimation and determine the robustness of the findings. In doing so, we extended our identification strategy and performed the Tobit estimation on the equation (1). Instead of using the logarithm of a number of grants, as in the GLS estimation, we use a number of grants received by a firm in 2019-2020. The variable “number of grants” varies between 0 (no grants) and 51 (maximum number of grants), with the results significantly skewed towards zero. Interestingly, only 819 firms from our total sample of 2683 companies had secured an innovation grant, while 1864 firms had not received the grant. Figure 3 demonstrates the number and frequency of firms who received an innovation grant.

INSERT FIGURE 3 HERE

Figure 3 clearly illustrates that our dependent variable left-censored and requires the use of Tobit models for the censored dependent variable (Amemiya, 1985). Tobit estimation, in addition to GLS estimation ofthe same equation (1) and using the same dependent variable, becomes an adequacy test to our GLS model estimation. In econometric form the model has dependent variable y_{it} (number of grants) as a function of a set of explanatory and control variables, as in equation (1). We estimate equation (1) using a multivariate Tobit model for each of three samples: 2015, 2017, and 2019.

Tobit estimation is unbiased, as it considers a significant share of firms who do not apply and secure innovation grants as well as firms who do so. Our H1a, which states that bank lending will reduce grant fundraising in women-led firms in the long term, is supported (β=-0.56; $p<0.05$) (spec. 7, Table 5). Our estimation using a Tobit approach in economic term means an average 10% higher level of bank lending lagged 5 years (2015) is associated with an average 5 fewer grants in 2020. Our H1b, which states that an increase in bank lending increases grant fundraising in women-led firms in the short term, is not supported as the coefficient is not statistically significant (β=-2.89; $p>0.10$) (spec. 3, Table 5). This finding is different from the GLS estimation as the effect was negative (β=-0.029; $p<0.05$) (spec. 3, Table 4).

Our H2a and h2b are not supported, as an increase in equity financing in women-led firms is not associated with changes in grant funding neither in the long- nor in the short-term (spec. 1-7, Table 5). However, the direct effect of equity funding on grant fundraising is positive and significant. This also supports our finding in Table 4 using the GLS estimation when H2a and H2b were not supported.

Our Tobit estimation supports H3a, which states that in an increase in working capital increases grant fundraising in women-led firms in the long term, with the coefficient positive and statistically significant (β=0.37; $p<0.05$) (spec. 7, Table 5). In economic terms this means that an increase of working capital by on average 10 percent 5 years ago (2015) is associated with on average 3-4 more grants today (2019-2020). An increase in working capital reduces grant fundraising in women-led firms in the short term (β=-4.95; $p<0.05$) (spec. 3, Table 5), supporting H3b. Women are more risk-averse than men, and an increase in internal resources means the capital is available for innovation, which affects their decision-making on applying for more grants.

We performed three cross-sectional estimations using the GLS method because our dependent variable (logarithm of the number of grants) is only available for 2019-2020. We did not observe the dependent variable for 2015–2019. This means that there is no year variation in the dependent variable.

As part of the robustness check we performed a pooled regression for 2015–2019 with the dependent variable of 2020. We used time dummies to see if the effect is present and significant across time, and use the year 2019 as a reference year for time fixed effects. In fact, all time fixed effects are positive and significant. For the results of the Tobit pooled estimation, please refer to specification 8 (Table 5).

5. Discussion and Conclusion

Theoretical contributions

This study makes the following contributions to women entrepreneurship and business research literature. Firstly, by expanding the well-developed literature on women's entrepreneurship (Brush, 2006; Jennings and Brush, 2013; Morsy, 2020), we present a model and explain why and in which conditions women-led firms are more likely to increase grant fundraising. Our results confirm that the gender perspective can be used to explain the inter-temporal decision-making by female CEOs to apply and receive innovation grants. This decision is mainly driven by the access to bank lending and the amount of working capital available. Our findings expand contemporary research on the higher risk-aversion of women-led firms (Marlow and Patton 2005; Charness and Gneezy, 2012; Coleman and Robb, 2015; Eddleston et al., 2016) which explains their willingness and ability to access external funding. Their ability to access external funding is conditional upon availability of working capital and access to bank loans in every point in time.

Our critical contribution is to suggest that whilst women entrepreneurs are less likely to access external financing (Cowling et al., 2020), this is not the case with new industries that are highly innovative and technology driven. This technological novelty allows both women-led and men-led firms to signal equally regarding the quality of their goods and services. While women are known to be more marginal to external financing (Brush et al., 2014, 2019), they are as likely to succeed in accessing grant fundraising given the amount of equity funds. The most striking difference between female and male CEO in seeking grant funding is the time since a bank loan was secured and the amount of the working capital. For example, when bank lending increases the cost of borrowing, this may encourage female CEOs to be more active in grant fundraising in order to avoid an increasing cost of external finance. This effect is also valid if women have greater working capital. In the short term, it may lead to an unwillingness to apply and secure grant fundraising. In so doing, our study goes beyond a simple gender dichotomy in the new emerging industries and access to grant finance.

This study is unique because it draws on fundraising in new and emerging industries. These industries are different from the traditional industries where women entrepreneurs operate.

Traditional industries have often been male-dominated, while high-tech industries are seen as having a positive signal to investors (Alsos and Ljunggren, 2017; McAdam, 2013). Our findings provide new insight into who participates in innovation in new industries and how various sources of external and internal finance contribute to grant fundraising, thereby extending prior research on women fundraising for entrepreneurship (Ding et al., 2006; Dohse et al., 2019).

Managerial contributions

Differences in women's preferences, as described by Wellalage et al. (2020), could explain why women respond differently to investment risks and access to finance (Carter et al., 2015; Marlow and Martinez-Dy, 2018). Female CEOs have been often disadvantaged in terms of external fundraising because of their risk-aversion (Ahl, 2006, 2009). However, this study finds no differences in new industries in access and grant fundraising between women and men-led firms. Manager-owners should know that female CEOs have a limited preference for equity investment due to dilution of ownership and debt capital. This is a result of the high transaction costs of negotiation, collateral, and often different borrowing rates as a woman-led project may result in riskier lending (Balachandra et al., 2019). We partly support this finding for debt capital, in particular for long-term bank financing when access to this reduces grant fundraising. The high-risk aversion of female CEOs can be observed with bank loans, as an increase in bank lending may change the financing strategy and reduce grant fundraising in both the long- and short-term. We argue that female CEO will use time and working capital to further develop and test innovation, which is the reason why an increase in working capital reduces grant fundraising in the short term (Becker-Blease and Sohl, 2007).

Specifically, we are able to add richness and depth to our understanding of potential differences in: (i) the cost of financing and decision-making for firm managers; (ii) the incidence of borrower discouragement when working capital is available; and (iii) the inter-temporal effects which affects the number of grants received driven by higher uncertainty and risk. We can isolate and observe potential CEO gender effects on loan demand and working capital availability inter-temporarily, as well as on the role of equity financing. The differences arise from the type of finance available for women-led firms and their configuration, and the way in which capital is structured. Further, we are able to examine how gender-based differences in risk tolerance shape the type of capital available (De Bruin et al., 2006; Jennings and Brush, 2013) and its relation to grant fundraising. We also extend previous work in that we can further explore potential hidden gender differences in fundraising and the link to bank lending, equity investment, and working capital (Brush et al., 2014, 2019; Ladge et al., 2019; Audretsch et al., 2022).

Policy contributions

Policymakers have put more robust demands on the quality of entrepreneurial ecosystems, supporting the share of women-owned and women-led businesses (Brush et al., 2019). Unfortunately, the risk of investment in women-led projects persists in many ecosystems, limiting economic growth and value creation. In order to increase grant fundraising for innovation in women-led firms, policymakers need to control the cost of capital and take resource configuration in women-led firms into account when designing policies. As the cost of capital increases, female CEOs are likely to be discouraged from applying for loans and therefore innovating. This study also demonstrated that an increase in working capital might be a good substitute for grant fundraising. Policymakers could use this information to support innovation grants for women-led firms, in particular for those firms that have already acquired substantial working capital and may be reluctant to apply for a grant. Innovate UK and other funders may encourage women to further apply for innovation grants independently of the amount of working capital, which gives further flexibility and reduces the cost of innovation while bypassing debt and equity funding.

While the COVID-19 pandemic significantly reduced demand for products in certain new industries, it also gave tech-based sectors an opportunity to grow. These new industries are at the forefront of innovation in healthcare, the public sector, and high-tech manufacturing, and are both economically viable and socially necessary. Financing these sectors should remain an innovation policy priority, with the policy orientation on non-discrimination and availability of financing based on performance and not the combination of existing capital. While women are generally more risk-averse, this needs to be considered when designing the grant applications in a way that could complement the existing working capital equity and debt financing rather than acting as a substitute for these types of finance.

Policies designed to reduce the gap for women in innovation activities usually fight against gender segregation in society. At the same time, policymakers need to refocus on fighting against gender segregation in IP rights and retained profits, which are reinvested in knowledge. Programs aiming to increase the variety of alternative funding sources are the most efficient tools to reduce the gap in innovation activity in women-led firms.

Limitations and future research

This study has several limitations. Firstly, we could not consider any psychological or neurological factors that could determine women's and men's CEO intrinsic qualities when making decisions related to risk and uncertainty. Secondly, we could not assume direct discrimination affected access to innovation grants and the likelihood of awards.

Further research may investigate the different outcomes of innovation and the complementarity between different sources of innovation finance. Using other proxies for innovation performance, including innovation adopted by the market such as imitative innovation, could be helpful for further research. Without controlling for the characteristics of female CEOs, we cannot fully confirm the gender perspective and the role of female CEOs in building external networks, which could eventually lead to greater working capital and a higher opportunity cost of innovation. Analysing women entrepreneurs in different age groups could reveal different risk-taking patterns, which could be a gap for subsequent research to address. Further research is needed to explore the inter-temporal effects of resource availability between investment in R&D, access to working capital, debt finance, and access to grant fundraising.

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Table 1. Sample distribution across industry, region, firm size, and stage of growth

Emerging sector	**#firms**	**% total**	**# firms with female CEO**	**(% female CEO)**	**Region**		
Voiceover Internet Protocol	36	1.36	3	8.33	Aberdeen region, Scotland	29	1.08
Cloud Tech	59	2.21	5	8.47	East Midlands	93	3.47
Meta-materials	6	0.21	1	16.67	East of England	212	7.90
Precision medicine	46	1.73 (6.22)	3	6.52	East of Scotland	102	3.80
Urban farming	12	0.45	1	8.33	Highlands and Islands, Scotland	10	0.37
Omnichannel	21	0.79	2	9.52	London	987	36.79
eHealth	151	5.63	11	7.28	North East	94	3.50
Regenerative medicine	29	1.09	2	6.90	North West	232	8.65
Drones	48	1.79	4	8.33	Northern Ireland	54	2.01
Smart homes	31	1.15	3	9.68	South East	338	12.60
Retail biometrics	5	0.18	1	20.00	South West	132	4.92
Robotics	52	1.94	4	7.69	South of Scotland	3	0.11
Precision agriculture	21	0.79	2	9.52	Tayside, Scotland	15	0.56
Digital (cyber) security	227	8.47	14	6.17	Wales	86	3.21
Preventive care	23	0.85	1	4.35	West Midlands	114	4.25
Wearables	111	4.15	10	9.01	West of Scotland	63	2.35
FinTech	36	1.33	3	8.33	Yorkshire and The Humber	119	4.44

IoT	171	6.36	15	8.77			
Bigdata	124	4.63	13	10.48	**Firm size**		
3D printing	6	0.21	1	16.67	1-9 FTEs	636	23.73
Mobile commerce	32	1.18	2	6.25	10-49 FTEs	892	33.25
Mobile Services	99	3.69	8	8.08	50-99 FTEs	440	16.38
Open source	44	1.63	3	6.82	100-249 FTEs	437	16.32
Sharing economy	69	2.57	5	7.25	250 and more FTEs	278	10.34
Cryptocurrencies	20	0.73	1	5.00			
Gamification	71	2.66	4	5.63			
Educational Technology	53	1.97	2	3.77			
Social shopping	19	0.70	1	5.26			
Advertising Tech	33	1.24	3	9.09	**Firm growth stage**		
Alternative finance	110	4.09	8	7.27	Seed	397	14.80
Augmented Reality	137	5.12	9	6.57	Venture	872	32.50
Artificial Intelligent	275	10.26	18	6.55	Growth	478	17.82
Insurance Tech	95	3.54	8	8.42	Established	584	21.77
Property Tech	179	6.66	13	7.26	Exited	296	11.03
virtual reality	174	6.48	12	6.90	Dormant	56	2.09
Law Tech	58	2.15	4	6.90			
Total firms	2683	**100.00**			**Total firms**	2683	**100.00**

Source: Beauhurst data (2020).

Table 2. Descriptive statistics

Variables	Description	Mean	St.dev	Min	Max
Grant financing	Number of innovations grants a firm has received from the the UK Research and Innovation funding and other agencies in logarithm. We created it logarithm of (1+ number of grants)	0.39	0.68	1.00	4.28
Number of grants received	Number of innovations grants a firm has received from the the UK Research and Innovation and other agencies	1.08	2.99	0.00	51
Seed	Firm growth stage: seed	0.15	0.36	0.00	1.00
Venture	Firm growth stage: venture – early growth	0.33	0.47	0.00	1.00
Growth	Firm growth stage: growth and expansion	0.22	0.41	0.00	1.00
Established	Firm growth stage: established firm	0.18	0.38	0.00	1.00
Exited	Firm growth stage: exited the market	0.11	0.31	0.00	1.00
Age	Firm age since the establishment in logarithms	1.92	0.95	0.00	4.74
Accelerator	Firm has participated in the accelerator program	0.19	0.39	0.00	1.00
Pinterest	Firm uses digital platform: Pinterest	0.28	0.45	0.00	1.00
Instagram	Firm uses digital platform: Instagram	0.51	0.50	0.00	1.00
Twitter	Firm uses digital platform: Twitter	0.87	0.34	0.00	1.00
LinkedIn	Firm uses digital platform: LinkedIn	0.93	0.25	0.00	1.00
Female CEO	A firm CEO is a female	0.09	0.17	0.00	1.00
Intangible assets	Total intangible assets (GBP) in logarithms	4.25	5.89	0.00	20.30

Bank loan	Total bank loans (GBP) in logarithms	7.09	6.58	0.00	20.87
Equity capital	Total equity capital (GBP) in logarithms	14.33	2.14	8.52	21.00
Working capital	Total working capital (GBP) in logarithms	12.19	3.20	0.00	24.35
Fundraising	Number of fundraising rounds	3.42	2.66	1.00	17.00

Source: Beauhurst data (2020).

Table 3: Correlation matrix

Grant financing	1																
Seed	0.059*	1															
Venture	0.093*	-0.253*	1														
Growth	-0.157*	-0.215*	-0.413*	1													
Established	-0.024	-0.179*	-0.345*	-0.290*	1												
Exited	0.038	-0.111*	-0.214*	-0.121*	-0.152*	1											
Age	-0.071*	-0.279*	-0.390*	0.692*	-0.127*	0.061*	1	1									
Accelerator	0.135*	0.004	0.135*	-0.225*	0.113*	-0.039	-0.270*	1									
Pinterest	-0.175*	-0.039	-0.005	-0.002	0.057*	-0.018	-0.049	0.085*	1								
Instagram	-0.225*	-0.054*	0.012	0.005	0.076*	-0.052*	-0.068*	0.090*	0.430*	1							
Twitter	0.015	-0.036	0.060*	-0.073*	0.060*	0.021	-0.060*	0.123*	0.189*	0.281*	1						
LinkedIn	0.056*	-0.099*	0.058*	-0.050*	0.062*	0.039	-0.056*	0.108*	0.075*	0.108*	0.233*	1					
Female CEO	-0.028	-0.004	0.059*	-0.047*	-0.004	-0.032	-0.044	0.025	0.088*	0.060*	-0.002	-0.014	1				
Intangible assets	0.008	-0.116*	-0.101*	0.079*	0.065*	0.096*	0.094*	-0.038	0.029	0.011	0.022	0.066*	-0.012	1			
Bank loan	-0.101*	-0.200*	-0.305*	0.322*	0.099*	0.110*	0.360*	-0.095*	0.049*	0.084*	0.016	0.004	-0.017	0.232*	1		
Equity capital	0.142*	-0.276*	-0.007	-0.052*	0.190*	0.124*	-0.058*	0.193*	0.038	0.022	0.056*	0.111*	-0.024	0.220*	0.155*	1	
Working capital	-0.043	-0.331*	-0.246*	0.317*	0.109*	0.148*	0.309*	-0.039	0.025	0.024	0.003	0.056*	-0.055*	0.239*	0.398*	0.455*	1
Fundraising	0.237*	-0.111*	0.203*	-0.305*	0.165*	0.018	-0.275*	0.285*	0.04*	0.042	0.101*	0.104*	0.014	0.087*	-0.162*	0.534*	0.071*

Source: Beauhurst data (2020).

Table 4: Generalised least squares regression with robust standard errors.
Dependent variable: number of innovation grants received by a firm

Specification	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Year of analysis		2019		2017		2015	
Seed	-0.129	-0.017	-0.028	-0.028	-0.031	-0.016	-0.021
	(0.11)	(0.14)	(0.14)	(0.12)	(0.12)	(0.10)	(0.10)
Venture	-0.054	-0.106	-0.111	-0.0643	-0.0638	-0.101	-0.104
	(0.11)	(0.14)	(0.14)	(0.12)	(0.12)	(0.10)	(0.10)
Growth	-0.376***	-0.333**	-0.341**	-0.320**	-0.325**	-0.317***	-0.321***
	(0.11)	(0.14)	(0.14)	(0.13)	(0.13)	(0.10)	(0.10)
Established	-0.153	-0.235*	-0.244*	-0.209*	-0.214*	-0.246**	-0.250**
	(0.11)	(0.14)	(0.14)	(0.12)	(0.12)	(0.10)	(0.10)
Exited	-0.169	-0.173	-0.179	-0.157	-0.158	-0.174	-0.179
	(0.11)	(0.14)	(0.14)	(0.13)	(0.13)	(0.11)	(0.11)
Age	0.084***	0.146***	0.144***	0.143***	0.144***	0.113***	0.112***
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.02)	(0.02)
Accelerator		0.152***	0.149***	0.128***	0.128***	0.162***	0.159***
		(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)
Pinterest	-0.116***	-0.143***	-0.146***	-0.114***	-0.113***	-0.133***	-0.132***
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
Instagram	-0.271***	-0.256***	-0.255***	-0.286***	-0.284***	-0.267***	-0.267***
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
Twitter	0.085**	0.099**	0.094**	0.071	0.070	0.073*	0.072*
	(0.04)	(0.05)	(0.05)	(0.05)	(0.05)	(0.04)	(0.04)
LinkedIn	0.182***	0.135***	0.133***	0.132**	0.131**	0.121***	0.122***
	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.04)	(0.04)
Female CEO	-0.026	-0.029	-0.032	-0.015	-0.018	-0.018	-0.029
	(0.06)	(0.07)	(0.07)	(0.07)	(0.06)	(0.06)	(0.07)
Intangible assets		0.002	0.003	-0.001	-0.001	-0.001	-0.003
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Bank loan		0.002**	0.003**	0.003**	0.004**	0.004*	0.005**
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Equity capital		0.024***	0.023***	0.028***	0.028***	0.035***	0.035***
		(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Working capital		0.001*	0.001*	0.001*	0.001*	0.002*	0.002*
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Fundraising		0.044***	0.045***	0.041***	0.041***	0.038***	0.031***
		(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Female CEO x Intangible assets			-0.021		0.001		0.014
			(0.01)		(0.02)		(0.02)
Female CEO x Bank loan (H1a, H1b)			-0.029**		-0.024**		-0.028***
			(0.01)		(0.01)		(0.01)

Female CEO x Equity capital (H2a, H2b)			0.010		0.001		-0.015
			(0.02)		(0.02)		(0.01)
Female CEO x Working capital (H3a, H3b)			-0.001*		0.006		0.024**
			(0.00)		(0.02)		(0.01)
Industry: Fintech	-0.321***	-0.441***	-0.437***	-0.435***	-0.430***	-0.388***	-0.385***
	(0.04)	(0.04)	(0.05)	(0.05)	(0.05)	(0.04)	(0.04)
Industry: Internet of Things	0.372***	0.387***	0.391***	0.329***	0.327***	0.345***	0.342***
	(0.08)	(0.09)	(0.09)	(0.09)	(0.09)	(0.07)	(0.07)
Industry: Sharing economy	-0.168***	-0.228***	-0.248***	-0.271***	-0.273***	-0.187***	-0.202***
	(0.06)	(0.08)	(0.08)	(0.07)	(0.07)	(0.06)	(0.06)
Industry: Augmented reality	0.214*	0.275**	0.277**	0.141*	0.141*	0.208*	0.207*
	(0.12)	(0.13)	(0.13)	(0.11)	(0.11)	(0.11)	(0.11)
Industry: Artificial intelligence	0.200**	0.132	0.133	0.168*	0.165*	0.148*	0.146*
	(0.08)	(0.09)	(0.09)	(0.09)	(0.09)	(0.08)	(0.08)
Constant	0.258**	-0.349*	-0.328*	-0.314*	-0.316**	-0.296**	-0.292**
	(0.13)	(0.19)	(0.19)	(0.17)	(0.12)	(0.14)	(0.14)
Number of observations (firms)	2683	2683	2683	2683	2683	2683	2683
R2	.31	.38	.39	.37	.38	.38	.38
RMSE	.64	.62	.61	.62	.62	.61	.61
F stat	16.10	15.65	13.98	15.44	13.69	19.48	17.45
loglikelihood	-2600.95	-1932.14	-1929.71	-2063.05	-2061.56	-2496.93	-2494.43

Note: Level of statistical significance is * 10%; ** 5%. and *** 1%. Standard errors are in parenthesis and are robust for heteroskedasticity. Other new industries and regional fixed – effects are included but suppressed to save space.
Source: Authors calculation based on Beauhurst data (2020).

Table 5: Tobit estimation. Dependent variable: number of grants received

Specification	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Year of analysis		2019		2017		2015		Tobiit Pooled 2019-2015
Seed	-1.930	-2.882	-2.919	-3.024	-2.983	-0.054	-0.152	-0.022
	(4.93)	(6.15)	(6.07)	(6.25)	(6.19)	(1.11)	(1.11)	(0.10)
Venture	2.315	-3.028	-3.711	-4.158	-4.642	-1.354	-1.395	-0.144
	(1.81)	(3.53)	(3.51)	(3.17)	(3.16)	(1.05)	(1.06)	(1.06)
Growth	-3.561**	-3.505	-3.328	-5.944**	-5.748**	-3.430***	-3.474***	-2.56***
	(1.50)	(3.25)	(3.20)	(2.92)	(2.89)	(1.15)	(1.15)	(0.77)
Established	-1.906	-2.793	-2.759	-4.661	-4.565	-2.787**	-2.846***	-1.361***
	(1.57)	(3.28)	(3.24)	(2.98)	(2.95)	(1.09)	(1.10)	(1.10)
Exited	-0.0904	-1.136	-0.985	-2.585	-2.388	-1.485	-1.547	-1.172
	(1.56)	(3.27)	(3.23)	(2.94)	(2.92)	(1.13)	(1.13)	(1.59)
Age	0.954***	1.371*	1.237**	1.072**	1.050**	1.358***	1.338***	1.420***
	(0.33)	(0.78)	(0.67)	(0.53)	(0.62)	(0.25)	(0.25)	(0.35)
Accelerator		0.185	0.157	0.336	0.341	2.139***	2.095***	1.725***
		(1.63)	(1.62)	(1.66)	(1.65)	(0.40)	(0.40)	(0.12)
Pinterest	-0.381	-1.213	-1.017	-0.155	-0.002	-1.643***	-1.654***	-1.501***

	(0.46)	(1.04)	(1.03)	(1.06)	(1.05)	(0.41)	(0.41)	(0.51)
Instagram	-1.854***	-1.642*	-1.588*	-1.722*	-1.642*	-2.875***	-2.877***	-2.281***
	(0.40)	(0.92)	(0.91)	(0.97)	(0.96)	(0.36)	(0.36)	(0.46)
Twitter	2.286***	2.951**	2.760**	1.245**	1.018**	0.877**	0.897*	0.785**
	(0.50)	(1.36)	(1.35)	(.66)	(0.51)	(0.49)	(0.51)	(0.38)
LinkedIn	2.617***	3.801*	3.676*	4.448**	4.364**	1.429**	1.481**	1.211**
	(0.60)	(2.13)	(2.10)	(2.24)	(2.22)	(0.69)	(0.70)	(0.60)
Female CEO	-1.951	0.153	-1.521	0.523	0.237	-0.247	-0.437	-0.587
	(1.52)	(3.53)	(1.00)	(1.01)	(0.24)	(0.34)	(0.51)	(0.44)
Intangible assets		-0.026	-0.017	-0.025	-0.015	-0.016	-0.017	-0.007
		(0.06)	(0.06)	(0.06)	(0.06)	(0.03)	(0.03)	(0.01)
Bank loan		0.0564	0.0574	0.024**	0.020**	0.052*	0.062**	0.025**
		(0.10)	(0.10)	(0.01)	(0.01)	(0.03)	(0.03)	(0.01)
Equity capital		0.429**	0.410*	0.260**	0.244**	0.451***	0.457***	0.299***
		(0.22)	(0.21)	(0.12)	(0.12)	(0.10)	(0.10)	(0.03)
Working capital		0.091	0.097**	0.362**	0.368**	0.037**	0.051**	0.012**
		(0.06)	(0.04)	(0.12)	(0.12)	(0.02)	(0.02)	(0.00)
Fundraising		0.704***	0.727***	0.782***	0.812***	0.381***	0.380***	0.390***
		(0.16)	(0.16)	(0.17)	(0.17)	(0.07)	(0.07)	(0.08)
Female CEO x Intangible assets			-5.107		-3.547		0.146	-0.080
			(8.61)		(8.15)		(0.20)	(0.06)
Female CEO x Bank loan (H1a, H1b)			-2.891		-0.121**		-0.561**	-0.327**
			(1.97)		(0.05)		(0.20)	(0.18)
Female CEO x Equity capital (H2a, H2b)			11.161		0.405		0.238	0.052
			(8.08)		(0.24)		(0.25)	(0.11)
Female CEO x Working capital (H3a, H3b)			-4.95***		1.412		0.370***	0.120***
			(1.59)		(1.38)		(0.10)	(0.03)
Industry: Fintech	-4.389*	-6.329*	-6.457*	-7.253**	-7.443*	-5.641***	-5.614***	-6.640***
	(2.58)	(3.66)	(3.62)	(3.58)	(3.97)	(1.01)	(1.01)	(1.55)
Industry: Internet of Things	4.754*	2.161*	2.183**	0.820**	0.745**	2.685***	2.624***	2.584***
	(2.45)	(0.99)	(1.13)	(.47)	(0.31)	(0.71)	(0.71)	(0.21)
Industry: Sharing economy	-29.320	-13.670	-19.760	-4.447	-3.92	-3.687	-3.976	-2.933
	(30.55)	(11.45)	(13.44)	(5.45)	(3.11)	(2.45)	(2.47)	(2.07)
Industry: Augmented reality	13.70***	11.71**	11.75**	11.06**	11.29**	2.340*	2.337*	1.937***
	(4.26)	(5.76)	(4.67)	(5.74)	(4.70)	(1.25)	(1.25)	(0.52)
Industry: Artificial intelligence	4.044	3.632	3.428	1.491	1.319	1.683**	1.651**	0.900**
	(2.95)	(3.81)	(3.77)	(3.82)	(3.79)	(0.72)	(0.72)	(0.22)
Time fixed effects Year 2015								0.925***
								(0.17)
Time fixed effects Year 2017								0.523***
								(0.15)
Constant	-12.30***	-17.22***	-16.34***	-8.29**	7.42**	-12.34***	-12.26***	-10.16***

	(1.94)	(6.07)	(5.99)	(3.95)	(3.69)	(1.87)	(1.87)	(3.07)
Variance(u)	46.26***	42.27***	41.16***	47.61***	46.64***	38.26***	38.18***	28.28***
	(3.56)	(5.96)	(5.79)	(6.53)	(6.39)	(2.08)	(2.07)	(3.15)
Number of observations (firms)	2683	2683	2683	2683	2683	2683	2683	8049
No of left censored	1864	1864	1864	1864	1864	1864	1864	5592
No uncensored	819	819	819	819	819	819	819	2457
chi-squared	167.02	90.09	97.28	91.84	98.47	435.91	443.39	2791.58
loglikelihood	-2401.59	-566.61	-563.01	-600.01	-596.70	-3397.58	-3393.87	-17373.01

Note: Level of statistical significance is * 10%; ** 5%. and *** 1%. Standard errors are in parenthesis and are robust for heteroskedasticity.
Other new industries and regional fixed – effects are included but suppressed to save space. Year 2019 is a reference year for time fixed effects
Source: Authors calculation based on Beauhurst data (2020).

Figure 1: Conceptual model of hypothesis testing.

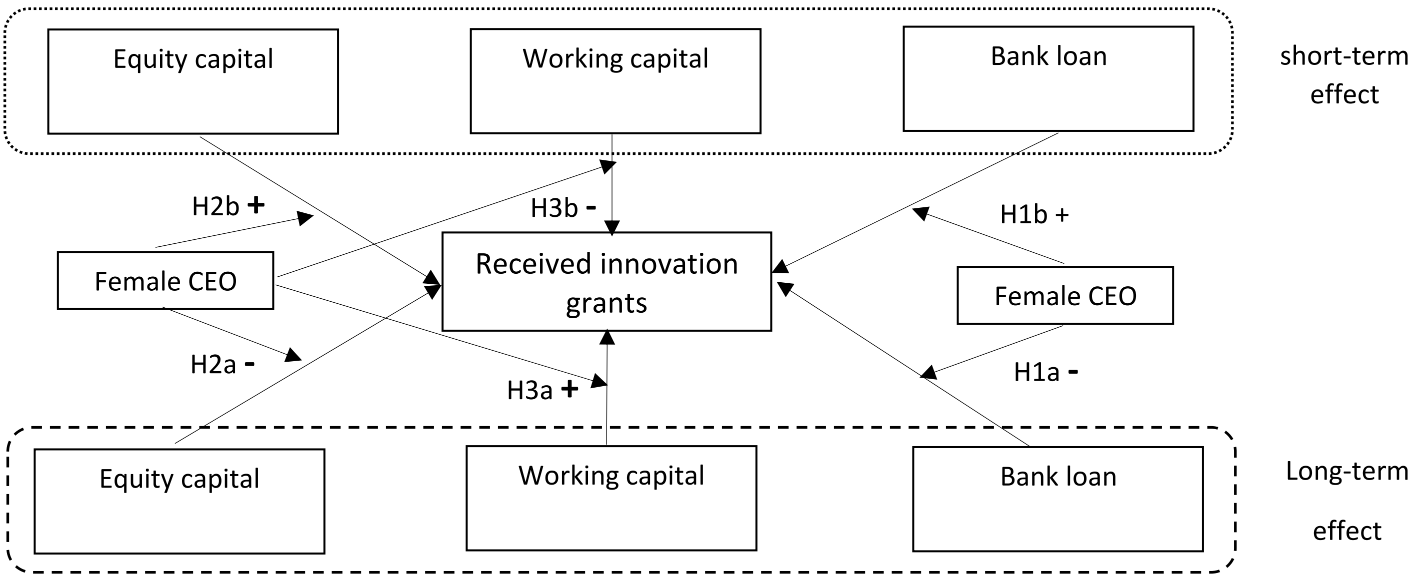
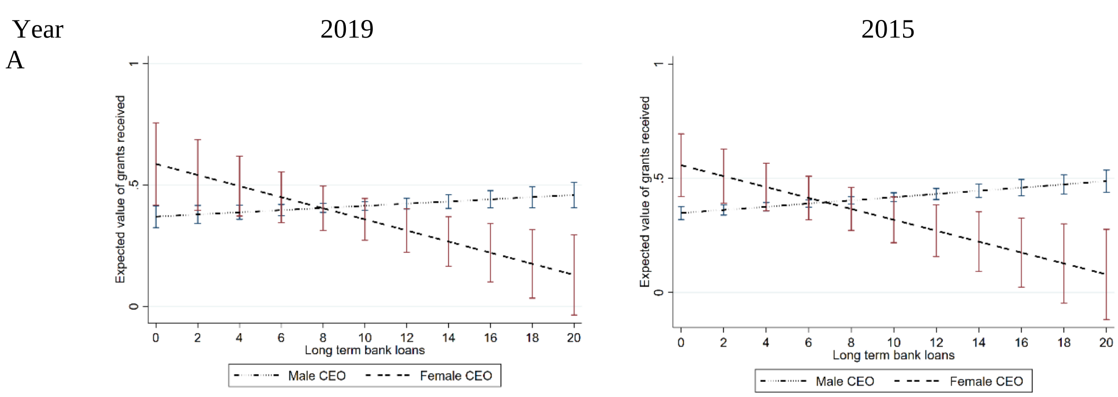
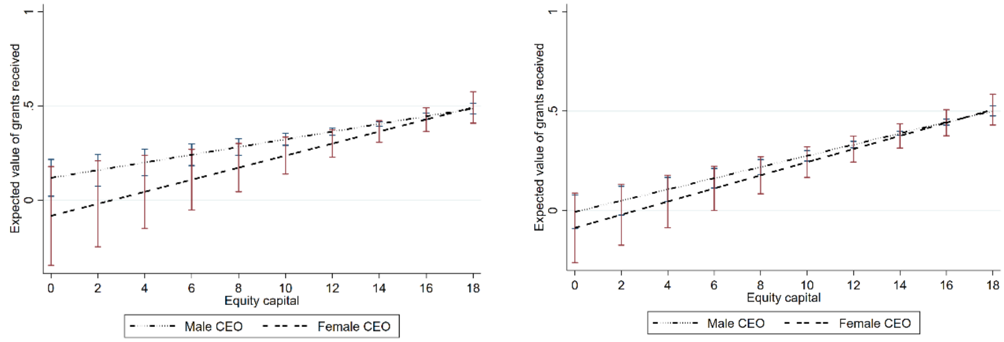


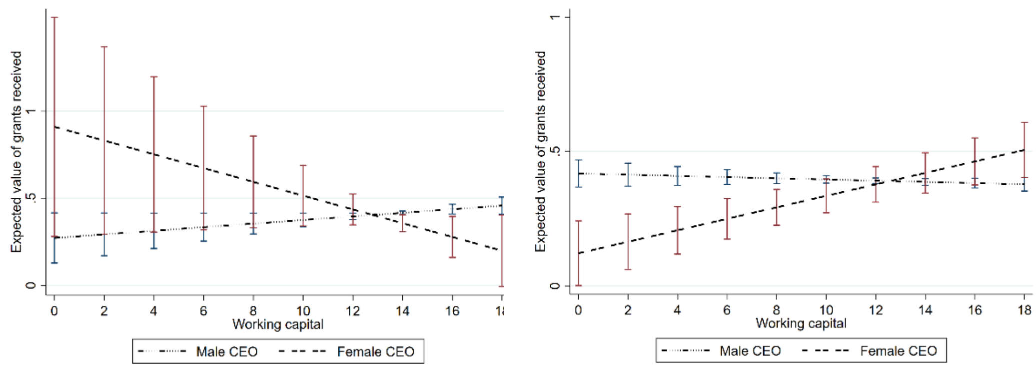
Figure 2. Predictive Margins of the effect of various types of finance on the propensity of innovation grant received in women and men-led firms



B

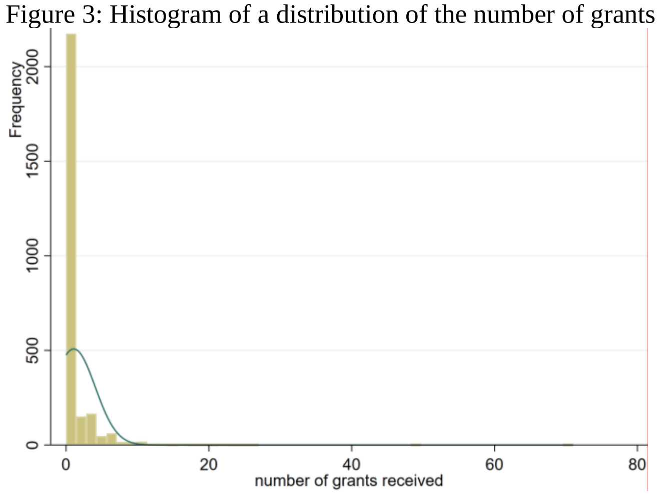


C



Source: Authors calculation based on Beauhurst data (2020).

Figure 3: Histogram of a distribution of the number of grants



Source: Authors calculation based on Beauhurst data (2020).