



What impact does equity crowdfunding have on SME innovation and growth? An empirical study

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Abstract We examine the impact of equity crowdfunding on innovation and growth opportunity within small- and medium-sized enterprises. While previous studies have generally focused on the realm of crowdfunding and how it can close the financing gap for small firms, recent academic attention has turned toward assessing the outcome of equity crowdfunding, measured in terms of successes (or failures) in post-campaign firm financing. Using data from Fame BVD for small firms operating in the UK, we investigate whether equity crowdfunding can act as a catalyst for innovation and growth. The findings show that crowdfunding does not have a significant influence on innovation in small firms, thereby disproving the proposition that the use of crowdfunding leads to an increase in innovation. Nonetheless, crowdfunding does have an impact on the growth opportunity of small firms, with a strong positive correlation. Our further tests on return on assets models and propensity score and controlled firm-matching models show a positive impact of crowdfunding

on small firms' performance. We also discuss the implications of our findings for small firms' use of equity crowdfunding for business growth opportunities.

Keywords Equity crowdfunding · Small- and medium-sized enterprises · Innovation · Growth opportunity · Performance

JEL classifications G24 · G32 · M13 · M21 · L26

1 Introduction

In a perfect world, entrepreneurs and small- and medium-sized enterprises (SMEs) would have easy access to finance, which would stimulate innovation and drive subsequent growth (OECD 2012). However, in reality, a disparity exists between the supply and demand for financing¹; this disparity is mainly driven by financial institutions, such as commercial and investment banks, that financially under-serve small firms. The contention is that SMEs demonstrate inherent riskiness and weaknesses such as a lack of robust business plans and insufficient capital. Nonetheless, with SMEs typically representing a major business segment, they form the backbone of an economy and represent an

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¹ “There remains, however, a continued and long run debt funding gap in the SME business lending market. There is an estimated potential finance gap, which is not currently covered by mainstream finance, of £1.3 billion and 103,000 clients per annum” (Royal Bank of Scotland 2013); “540,000 businesses in the UK are unsure about being able to access the finance they may need to grow or even survive” (Close Brothers 2016).

essential source of economic growth; it is thus imperative to provide alternative financing options for this business segment (Robu 2013; Gros 2016). Crowdfunding is a recent phenomenon within financial services; in particular, the global financial crisis of 2008 gave impetus for banks to retrench from riskier financing (loans to new businesses), and provided traction toward crowdfunding as an alternative to traditional bank-financing (Ahlstrom et al. 2018; Dunkley 2016).² An expansive volume of literature has highlighted this phenomenon and how it is closing the financing gap (Belleflamme et al. 2014; Cichy and Gradon 2015), including studies that examine any possible mismatches between firm characteristics and financing instrument(s) (Naudé 2010).

Against this background, prior research on equity crowdfunding (ECF) has focused on issues that are tied to information asymmetry concerns, since investment in this area characterizes decision-making under extreme risk. Ahlers et al. (2015) argue that information asymmetries prevalent in equity investments exacerbate adverse selection risk for investors in young firms. In addition, limited investor expertise means that there is greater uncertainty associated with equity investments, resulting in both adverse selection risks and moral hazard problems (Steinberg 2012; Mohammadi and Shafi 2018; Fama and Jensen 1983). Researchers also explored various avenues within the crowdfunding environment such as crowdfunding as a value-creation tool (Baumgardner et al. 2015; Ahlers et al. 2015), with social capital identified as a key factor in how entrepreneurs succeed in their crowdfunding campaigns (Vismara 2016; Agrawal et al. 2015) and achieve crowdfunding success through the start-up life cycle stages (Paschen 2017; Hornuf and Schmitt 2016). A further area of research that has only recently attracted researchers' attention is post-offering outcome of ECF campaigns or what happens after a successful crowdfunding campaign. For instance, Signori and Vismara (2018) emphasize the role of investor participation and the presence of qualified investors as important determinants of post-campaign success, although, as they found, most current exits in equity crowdfunding are bankruptcies.

Moreover, as Signori and Vismara (2018) showed, a significant proportion of companies that raised funds

through crowdfunding went on to raise further capital, indicating that the prospect of a monetary return existed for initial crowdfunding investors. Hornuf et al. (2018) found that both the number of senior managers and the number of initial venture capital investors had a positive impact on likelihood to obtain post-campaign financing, although they also found that the average age of the senior management team had a negative impact. Walthoff-Born et al. (2018) compared the performance of equity-crowdfunded firms to similar firms that raised capital from other sources. While equity-crowdfunded firms exhibited significantly higher failure rates than matched firms, they found that nominee shareholder structures in ECF were positively associated with firm financial performance. Studies have also examined how investors' access to a two-sided online social media platform (Cumming and Zhang 2016; Evans and Schmalensee 2016; Rossi and Vismara 2017) can become a market-maker (Estrin et al. 2018). For example, social media marketplaces may facilitate the transfer of knowledge through the use of various social network instruments such as posts, followers, and comments. We build on this research stream and evaluate whether ECF has an impact on innovation and growth opportunity (GO), thus further contributing to our understanding of what happens to ECF firms after a successful crowdfunding campaign. Although a few studies exist on the link between crowdfunding and SMEs research on the crowdfunding-innovation relationship is limited, with publications emphasizing (i) cost of crowdfunding for SMEs (Kuzma 2015), (ii) crowdfunding as a mechanism for SME financing (Cichy and Gradon 2015), and (iii) the model of crowdfunding to best support SMEs (Naudé 2010).

The growing significance of ECF, combined with the potential benefits to SMEs and a lack of empirical research, highlights a gap for research (Kuzma 2015; Bruton et al. 2017). Accordingly, in this study, we examine whether the utilization of crowdfunding leads to an increase in innovation and GO, ultimately posing as a catalyst for SME growth. In the domain of equity crowdfunding, tapping the crowd for financial resources entails a spectrum of related processes between the entrepreneurs and the crowd. For example, investors can use their communication with peers and entrepreneurs as a learning tool. Therefore, entrepreneurs can realize several goals, like testing products in order to develop their brand and promoting a loyal customer base (Ordanini et al. 2011; Schwienbacher and Larralde

² New business lending to SMEs within the UK declined by £14,810,000,000 between 2008 and 2014, from £37,388,000,000 to £22,578,000,000.

2012; Estrin et al. 2018). Moreover, information cascades that emerge when network participants can watch the investment decisions of other investors may allow for the speedy and costless transfer of knowledge from customers to the entrepreneurs (Vismara 2018). We thus investigate the extent to which ECF impacts performance and growth opportunity of SMEs through the influence mechanism of the wisdom-of-crowd effect (Polzin et al. 2017; Herve and Schwiendbacher 2018). Our analysis of data collected through the Fame BVD database for SMEs operating in the UK for the 2014–2017 period suggests that ECF does not improve SME innovation; however, SMEs exhibited an increase in growth opportunity (GO) following the use of crowdfunding. Return on assets (ROA) regression results provided further support for a positive impact of ECF on SME performance. To address the potential issues of endogeneity and self-selection, we use propensity score and controlled firm-matching methodologies to eliminate any unobserved factors which may simultaneously determine crowdfunding and SME performance.

The paper proceeds as follows. The following section explores the existing literature on the emergence of crowdfunding, utilization of crowdfunding by SMEs, and determinants of SME growth. With numerous publications on crowdfunding and SMEs, a literature review is deemed imperative to highlight the existing research gap and validate the significance of our study. Moreover, we identify the hypotheses which will be examined in this paper. The next section explains the selected research methodology, and describes and discusses the sample data, test results, and findings. The final section concludes with the limitations and implications of this study, along with solutions for overcoming existing problems when undertaking future research.

2 Literature review

2.1 The crowdfunding domain

The potential economic benefits arising from the employment of crowdfunding as a financing instrument merit further exploration of the domain of crowdfunding; more specifically (1) the emergence of crowdfunding and (2) different crowdfunding models. Baumgardner et al. (2015) propose that the origins of crowdfunding stem from the micro-financing model; for example, the earliest documentation of crowdfunding

dates back to the 1200s in Ireland, where famine widespread. In the following years, while the barriers-to-entry for institutional finance had been surpassed, crowdfunding had failed to gain traction.³ Belleflamme et al. (2014) and Harrison (2013) assert that the development of the Internet and Web 2.0 technologies were critical in propelling the crowdfunding movement, as entrepreneurs now had access to a global investment pool, and information could be disseminated without the hindrance of geographical boundaries. Harrison (2013) elucidates crowdfunding as the utilization of the internet to “democratize fund raising” by individuals and businesses. Later works supported these conclusions, but added that while technological developments surpassed barriers-to-entry and provided easier access to finance for SMEs, the global financial crisis of 2008 paved the way for significant changes, primarily on the supply side (Ahlstrom et al. 2018; Block et al. 2018). With an estimated market size of \$34 billion in 2015, it is not surprising that recent alternative finance literature has emphasized crowdfunding, which is becoming a spectacle within the financial ecosphere.

For example, studies have examined how social networks allow entrepreneurs to reach a large number of backers; because network participants can watch the investment decisions of other investors, this potentially creates information cascades (Vismara 2018). Moreover, social capital could be a key factor in how entrepreneurs succeed in their crowdfunding campaigns (Agrawal et al. 2015; Vismara 2016; Dorfleitner et al. 2018). This literature stream also investigates issues such as pricing and regulation (Hornuf and Schwiendbacher 2017) and distance effects (Guenther et al. 2017; Agrawal et al. 2015; Mohammadi and Shafi 2018). Hornuf and Schmitt (2016) and Block et al. (2018) emphasize the state of a country’s regulatory system as a contributing factor in driving crowdfunding growth; stronger regulation enables entrepreneurial finance by lowering entry cost and ensuring contractual certainty. Equity crowdfunding is the provision of funds by participants in return for equity

³ Marillion, a British rock band, raised \$60,000 USD through an internet-based crowdfunding platform in 1997 for their US tour (Cichy and Gradon 2016). Blender, a widely used three-dimensional animation software developer, employed a crowdfunding campaign in 2002 after the dot.com crisis and raised 100,000 EUR within 7 weeks (Belleflamme et al. 2014). The total global crowdfunding industry-estimated fundraising volume in 2015 was \$34 billion. Breakdown is as follows: P2P Lending - \$25 billion, Reward and Donation Crowdfunding - \$5.5 billion, Equity Crowdfunding - \$2.5 billion.

shares in a company; typically utilized in the early stages of development. Belleflamme et al. (2014) posit that shareholder value is enhanced as participants have access to company founders and updated information. Conversely, Miglo and Miglo (2018) postulate that as equity crowdfunding eventually dilutes ownership of fundraisers, they will inherently demonstrate profit-maximizing tendencies,⁴ potentially subjecting participants to information asymmetry and moral hazard costs. Nonetheless, ECF produces the largest amount of funds on a campaign, primarily due to the fact that other crowdfunding models require comparatively smaller loans (Lukkarinen et al. 2016). However, in comparison, it exhibits the slowest growth due to a number of factors; Hornuf and Schmitt (2016) note that ECF has shown very low returns to investors and, to date, crowd exists are rare in Germany and the United Kingdom (UK). More firms in Germany than in the UK managed a crowd-exit through a significant VC round (Hornuf and Schmitt 2016).⁵

2.2 Crowdfunding, innovation, and SME growth

Past researchers offer different perspectives on the domain of crowdfunding and how it can impact opportunities for firm growth and development, with a general consensus that crowdfunding has the potential to provide support for SMEs in these particular areas. For example, there can be a number of non-financial benefits to SMEs utilizing crowdfunding, with the contribution toward incremental innovation viewed as the greatest benefit, as it promotes SME growth (Paschen 2017; Stanko and Henard 2016). However, numerous studies purport different levels of impact, which are dependent on other factors. These findings merit establishing a model which accurately depicts the relationships between crowdfunding and innovation, and between crowdfunding and GO. However, this can be challenging to achieve, due to the dynamics of the industry, firm age, and other factors, thus making it difficult to remove inconsistencies in results.

⁴ The fund-raising firm has flexibility in raising the initial amount of investments, since the funders can also count on the second period's (future profits). In period 2, the firm selects price, P_2 to maximize the entrepreneur's profit $(1-A)(P_2-C)(A-P_2)$, which makes $P_2 = A + C$ (Miglo and Miglo 2018).

⁵ The US crowdfunding market size is estimated at \$17.3 billion, with North America responsible for \$17.2 billion and South America responsible for \$85.74 million (Crowd Expert 2016).

Nonetheless, ECF should increase the level of innovation within a SME, due to idea generation and external feedback from backers; for example, in Herve and Schwienbacher's (2018) survey paper, these influence mechanisms play an important role in establishing the link between innovation and entrepreneurial firms.

The traditional context in which ECF campaigns are analyzed is to employ the information asymmetry approach, building on agency theory that studies information asymmetries between investors and managers (Fama and Jensen 1983), and then examine different theoretical mechanisms that potentially alleviate the negative consequences of such asymmetries for ECFs. For example, in an ECF campaign, fundraisers release the financing information on the website; that is, equity crowdfunding uses the internet as a carrier to send a financing signal to the market. However, whether equity financing is successful depends on the strength of the financing signal, meaning that whether the investors can fully acquire information related to ECF risk is the key to achieving their financing objectives (Fama and Jensen 1983; Steinberg 2012;). Ahlers et al. (2015) examined the effectiveness of signals that entrepreneurs use to induce (small) investors to commit financial resources in an ECF context. Their study employs the completion ratio (CR) (raised amount/target amount) to measure the financing risk; the proportion of high project financing means low financing risk, and vice versa. Ahlers et al. (2015) considered three major signals to reflect project quality: *human capital*, *social capital*, and *intellectual capital*. Regarding the human capital, it is widely recognized that high human capital relates to high educational degree of employees who have high skills and capabilities. They would be able to explore the potential opportunities and design strategies; therefore, it could be the signal to the success of a project. In respect to social capital, the networks of social relationships could be the source of acquiring information (Granovetter 1973; Brüderl and Preisendörfer 1998). Lastly, intellectual capital could be a determinant of the survival of project. According to Cefis and Marsili (2005), innovation can simultaneously allow new firms to enter the market while helping established firms secure their competitive positions and thus their survival. Thus, it is considered one of the signals to the success of the project, since it relates to the project's survival. However, Ahlers et al. (2015) concluded that, according to the data they collected, intellectual capital and social capital had little or no significant impact on funding success.

At the most basic level, as Herve and Schwienbacher (2018) have argued, ECF can reduce the funding gap for innovative start-ups by offering new sources of capital to innovation-driven firms. This is significant if crowdfunding acts as a source of finance to projects that would not be funded otherwise. Crowdfunding can also generate money in a more efficient way than traditional investors such as banks and professional equity investors (business angels and venture capital funds) can; it thus potentially contributes to innovation activities. There is another more subtle way through which crowdfunding can influence the innovation process within the start-ups. Crowdfunding can act as a conduit for the crowd to provide feedback to the entrepreneur. For example, crowds can provide ideas on the development of the product during and after the campaign, and extend valuable information on the future demand for the new product. In this way, crowdfunding enables the participation of the crowd in the innovation process itself. This is also the reason that crowdfunding is sometimes associated with crowdsourcing (Schwienbacher and Larralde 2012); this also clarifies the mechanism through which we observe the wisdom-of-crowd effect (Herve and Schwienbacher 2018). The principle of the wisdom-of-crowd states that the crowd displays more wisdom than an individual (even an expert) when solving problems or making decisions (Schwienbacher and Larralde 2012; Polzin et al. 2017). As the crowd can offer direct feedback on the product, it can potentially be more valuable to the firm than professional investors' guidance on business development. Not only can crowds provide a new source of financing to innovation-driven projects, they can also offer new ideas and feedback. It is in this context that we investigate our first hypothesis, as stated below.

H₁: Use of equity crowdfunding by an SME will increase its level of innovation

While there is a lack of studies in the area of crowdfunding and SME growth, it can be argued that crowdfunding supports SME growth by reducing the cost of financing and the provision of knowledge from external backers (Paschen 2017). However, Cumming et al. (2019) suggest that the degree of growth may be impacted by the model of crowdfunding that is used; as aforementioned, backers are more vested in equity crowdfunding models due to an investment stake and are therefore more likely to contribute to ideas and

provide feedback. Nonetheless, their findings suggest that crowdfunding reduces the requirement for long-term debt (which has a negative correlation with firm growth) by value creation, increasing the level of reserves within a firm, which allows for financing expansion. Consequently, a positive relationship is expected between crowdfunding and GO, as the provision of additional funding allows for the financing of growth. Stanko and Henard (2016) conducted a qualitative study to assess the contribution of crowdfunding to product development related research stages such as technology, product design, and hardware. Their findings suggest that the number of updates provided to backers and openness to external ideas are significant contributors toward increased innovation and subsequent growth. Paschen (2017) suggests that when SMEs utilize crowdfunding platforms, aside from gaining financing, they want external support to grow their businesses; thus, SMEs adopt an environment of openness, whereby they provide constant updates to backers, so that they can receive feedback to improve their products and enhance their understanding of customer preferences.

In a qualitative longitudinal study of entrepreneurs and investors, Estrin et al. (2018) found that investors use their communication with peers and entrepreneurs via the crowdfunding platforms to further develop their products and a loyal customer base (see also Ordanini et al. 2011). Although Estrin et al. (2018) acknowledged that equity crowdfunding cannot be a substitute for expert guidance provided by traditional early-stage financiers, it does hold promise for building a marketplace for the budding entrepreneurs in the sense that equity crowdfunding platforms can be used to create new growth opportunities. This is possible as participants on the ECF platforms can engage with each other through posts, comments and followers, creating a wisdom-of-crowd effect. In addition, information cascades potentially become a channel for the speedy and costless transfer of knowledge from customers to the entrepreneurs (Schwienbacher and Larralde 2012; Vismara 2018). We thereby suggest that ECF can be a catalyst for SME growth through the influencing mechanism of the wisdom-of-crowd effect (Polzin et al. 2017). While drawing on the domain of crowdfunding as explored above, in conjunction with SMEs, the following hypothesis will be tested.

H₂: Use of equity crowdfunding by an SME will increase its growth opportunity

An interesting question that is now gaining increasing attention is about understanding the outcome of equity crowdfunding or post-campaign crowdfunding outcomes. In a seminal study on this intriguing question, Signori and Vismara (2018) examine the post-offering outcome of equity crowdfunding campaigns by investigating successfully funded initial equity offerings in the UK. Their study shows that over the period from 2011 to 2015, 18% of the successfully funded firms in the UK failed, while 35% obtained one or more seasoned equity offerings (either from a private equity injection, or from another follow-on crowdfunding round on Crowdcube, or by being the target of an acquisition). Investor participation in the initial offering played a pivotal role in post-campaign success, although firms with more dispersed ownership were less likely to issue further equity. Importantly, none of the companies initially backed by qualified investors subsequently failed. Further, Hornuf et al. (2018) examine the determinants of follow-up funding and firm failure in the wake of an ECF campaign, and Walthoff-Borm et al. (2018) investigate the post-campaign financial and innovative performance of ECF firms. Walthoff-Borm et al. (2018) showed that the ECF firms had 8.5 times higher failure rates than matched non-ECF firms during their period of study, with 3.4 times more ECF firms making patent applications than matched non-ECF firms. These studies argue that ECF's unique selection mechanism—the wisdom-of-crowd—and extra-financial benefits that accrue from ECF are likely to be the reasons that ECF firms outperform non-ECF firms that raise other sources of capital. Cumming et al. (2019) explain that the wisdom-of-crowd effect may lead equity crowd investors to select firms that are equally (or even more) likely to create value than professional investors.

It is not only in equity crowdfunding that the wisdom-of-crowd effect can be found (Walthoff-Borm et al. 2018); lending-based crowdfunding (Bruton et al. 2017) is the other similar context in which we can see this principle operating. In addition, given that the crowd could succeed in selecting firms with greater financial potential, based on the participants' multiple perspectives and backgrounds, it is likely that ECF firms will generate positive post-investment performance. Moreover, from an economic perspective, funders face hidden information problems within crowdfunding investments due to the inability of the funders to control how funds are utilized. The beneficial infrastructure of social media platforms allows crowd funders to reduce these frictions

as funders can collate their own information through social media and observe any information asymmetry that a project may not provide. In addition, information is exchanged through social media that could promote information sharing and feedback. In these situations, the crowd/investors may be willing to help solve subsequent problems. As Walthoff-Borm et al. (2018) have argued, crowdfunding platforms serve as a feedback mechanism for the firm to improve its business operation and can thus achieve better performance. It is in this context that we also expect a positive relationship between ECF and SME performance. Ultimately, effects generated by the wisdom-of-crowd are likely to improve the financial performance of SMEs that have significant components of equity crowdfunding. Hence, we formulate our final hypothesis.

H₃: Use of equity crowdfunding by an SME will increase its financial performance

3 Research methodology

The global crowdfunding market has gained serious propulsion following technological developments, disruptive innovation, and financial disintermediation, as well as the events of the global financial crisis of 2008 (Ahlstrom et al. 2018). To track the performance of ECF firms, we employed multiple sources of information. We first used Crowdcube and TechCrunch to find information about SMEs with equity crowdfunding. We then obtained longitudinal accounting data on these firms from Bureau Van Dijk (BVD) Fame, which allowed us to use accounting data on all of our sample firms. All privately held firms in the UK are required to publish annual accounting data on Companies House. We collected patent data from BVD Orbis Europe; BVD acquires the patent data from the PATSTAT database—a worldwide database that contains bibliographical and legal status patent data. Four years of data were employed in this study; we started collating data on crowdfunding campaigns that were completed in 2013, with the following 4 years being assessed (Bureau Van Dijk 2017). ECF platforms in the UK have generated large financial flows for entrepreneurs, which accounted for nearly 40% of the global equity crowdfunding market in 2016 (Dushnitsky et al. 2016). It is estimated that, by 2016, ECF supplied more than 15% of the UK's

early-stage finance (Nesta 2016). Moreover, by June 2017, drawing on more than 400,000 registered potential investors, crowdfunding platforms including Crowdcube had supplied equity funds of almost £500 million for 1538 entrepreneurial pitches. It is important to mention that the percentage of ECF as a proportion of the total UK seed and venture stage equity investment has grown rapidly from just 0.3% in 2011 to 9.6% in 2014 and 15.6% in 2015 (Nesta 2016; Vulkan et al. 2016).

Because crowdfunding is still in its growth phase and has not yet been assessed as a metric on financial databases, selected companies were sourced from the Business Cloud (2016),⁶ which highlighted companies that had successfully utilized crowdfunding on the UK Crowdfunding platform, Crowdcube. Consequently, our initial sample included 240 UK SMEs. The SMEs had fulfilled the SME criteria as outlined by the European Union (2004) of having a maximum revenue of £25 (\$30) million, and also had Fame BVD's SME indicator. However, several companies had to be eliminated from the data sample for numerous reasons. With the most recent financial data required for companies in our sample size, we decided to exclude 10 companies from our sample, resulting in a sample size of 230 companies. This would ensure a more balanced dataset, thus increasing the reliability of our results. During the data collection process, income statement data, which were required for regression testing between crowdfunding and innovation, were not available for five (out of the available 230) companies. Therefore, these five companies were excluded from the linear regression testing between crowdfunding and innovation. However, as they included data relevant for the regression testing between crowdfunding and GO, they were included in the sample size.

3.1 Variables selection

In this study, we examine the impact of crowdfunding as the independent variable, and gauge its impact on the dependent variables, *innovation* and *GO*. Table 1 presents the study's variables and their definitions/operationalization. Crowdfunding has a goal to gather money for investment usually via an online platform (Ahlers et al. 2015; Vismara 2016). The fundraising

typically targets a small group of specific investors; however, the product or service of the entrepreneur needs not to be a niche one. This is because the online public audiences are large and can be from any part of the world and not restricted to a particular country. Each individual investor can deliver a relatively small amount of money to the company or entrepreneur and the total amount of money ultimately funded could be huge in terms of the size of the target audience (Belleflamme et al. 2014). It is in this context that Decarre and Wetterhag's (2014) study on the post-funding impact of crowdfunding used funds raised as a percentage of crowdfunding goal as a proxy for crowdfunding. However, the amount raised as a percentage of total equity (shareholders' funds plus money raised) could also be utilized as a proxy for crowdfunding, as it is viewed as a more encompassing and indicative measure than that highlighted by Decarre and Wetterhag (2014) and others. Cefis and Marsili (2005) suggest that innovation can simultaneously allow new firms to enter the market while helping established firms secure their competitive positions and thus their survival. Zhou and Li (2012) explain radical technological innovation in terms of the state of the internal knowledge base of an organization, combined with strategies for augmenting that knowledge to spark innovation. In particular, they find that firms with broad knowledge bases (knowledge of many topics), benefit most from internal knowledge sharing processes.

On the other hand, firms with deep knowledge (narrow expertise) benefit most from acquiring knowledge from outside the firm and integrating it—enhancing the wisdom-of-crowd effect (Herve and Schwiembacher 2018; Polzin et al. 2017). This is a sophisticated and networked view of the knowledge process for innovation generation. It considers how external knowledge might be captured, although the emphasis is also placed on the internal combination of knowledge. Understandably, innovation can be a difficult concept to measure due to its abstract nature; nonetheless, among many researchers, it is viewed as a component of competitiveness (Bruton et al. 2017; Herve and Schwiembacher 2018). A growth predictive system for SMEs may include innovation measures such as (1) innovation input ratio (innovation expenditure as a percentage of sales) and (2) net income growth rate (net income in current period less net income in previous period, as a percentage of net income in previous period). This is an indicator of the level of innovation in a company. Moreover,

⁶ Selected companies were extracted from <http://www.businesscloud.co.uk/news/crowdcubes-biggest-crowdfunding-success-stories-since-2011>

Table 1 Variables definition

Variable	Operationalization
Innovation	Net income growth rate
Patent	Patent is the number of granted patents
GO	Growth opportunity refers to the annual sales growth to total asset growth. The growth of sales and total assets are calculated by the difference of closing balance and opening balance in corresponding accounts in one accounting year
CROWDF	Amount raised as a percentage of total equity (shareholders' funds plus money raised)
AGE	Firm age is the numbers of years since the firm's establishment
TECH	Technology firms is a dummy variable, which is set to 1 for firms operating in the technology sector; otherwise, it is zero
SEED	SEED takes value one if a firm has received governmental seed investment; otherwise, it is zero
VC	If the SME introduced a lead investor (VC or angel), it takes value one; otherwise, it is zero
MGT	Number of directors and managers on each firm's board

patents can be used as another proxy for a small firm's innovation effort as these show the technical and R&D capabilities of the firm. Patents are also viewed as a valuable positive signal decreasing information asymmetry for investors (Hsu and Ziedonis 2013). For example, Walthoff-Borm et al. (2018) examined the post-campaign financial and innovative performance of ECF firms, and found that the equity-crowdfunded firms make 3.4 times more patent applications than matched non-ECF firms. In terms of measuring small firm growth, we can create a growth predictive system, which involves a plethora of growth indicators, such as solvency capabilities (gearing ratio), innovation (net income growth) and firm assets (TA or employees). As aforementioned, we identified numerous measures of firm growth, including sales revenue, total assets, employees, profit, and more. However, in this study, we used growth opportunity (GO) as it indicates firm growth within the context of sales performance, which is linked to our argument that ECF could be a channel through which the wisdom-of-crowd effect prevails. We include several control variables in our regression models, as described in Table 1. Age of firm can be observed directly as it means the number of years in operation. It is well known that nascent firms suffer from liabilities of newness and smallness (Stinchcombe 1965) and they also have short track records (Mohammadi and Shafi 2018). In our data, crowdfunders invest in firms that are 3.7 years old. It is also well known that technology firms are more engaged in developing and commercializing innovative projects than are other firms (Hall and Lerner 2012). Technology firms comprise 33% of the total firms. The involvement of prestigious external stakeholders (e.g., reputable VCs) may increase the legitimacy of the new firm. Several

studies including Stuart et al. (1999) argued that small firms can borrow the reputation and legitimacy of those firms. We also control for governmental seed investment; and whether the SME introduces a lead investor (VC or angel). We control for location in some of our analyses. As discussed, it is likely that entrepreneurs have a richer endowment of social capital from their home country (Dahl and Sorenson 2012). Hornuf et al. (2018) investigate whether follow-up equity crowdfunding campaigns impact funding by outside BAs/VCs. They showed that the number of senior managers is a significant predictor, among other factors, for increasing BA/VC follow-up funding after the latest successful equity crowdfunding campaign. Cumming et al. (2019) suggest that an ECF firm's formal board of directors with prominent directors may have more substantive effects on its behavior and success after the investment. In our analysis, we thus include the number of directors and managers on each firm's board. To capture possible temporal trends, we insert year fixed-effect in all models.

4 Model description

Table 2 presents the descriptive statistics, and Table 3 provides short-term market performance differences between a sample of ECF and non-ECF SMEs. As stated above, in the first instance, we created three regression models: (1) assessing the relationship between crowdfunding and innovation, (2) assessing the relationship between crowdfunding and patents, and (3) assessing the relationship between crowdfunding and GO. Therefore, model I presents the results of OLS

regression predicting small firms' innovation performance. Model II displays the results of OLS regression predicting small firms' patent grants. Finally, model III shows estimates of the OLS model predicting small firms' growth opportunity. The regression models are established as follows:

$$Y = \beta_0 + \beta_1 \text{CROWDF}_i + \beta_2 \text{AGE}_i + \beta_3 \text{TECH}_i + \beta_2 \text{SEED}_i + \beta_3 \text{VC}_i + \varepsilon_j, \quad (1)$$

where Y defines separately the following innovation proxies: innovation, patents, and growth opportunity.

In terms of the correlations between model variables, as shown in Table 2, each independent variable has an effective influence on SMEs with crowdfunding, but the direction and strength of their effect vary in innovation and patents. Specifically, crowdfunding has a positive effect on both of the innovation proxies, but it is significantly associated with patents with the coefficient of 0.061. It is similar to age which is positively correlated with the two dependent variables and the correlation with Patent is significant at 0.143. However, the correlation coefficients for technology companies go in the opposite direction as they have a positive effect on innovation but a negative and significant effect on patents (-0.237). On the contrary, the relationship between seed funding and innovation is negative but it is positive with another innovation measurement. Venture capital is the only one that has similar positive and moderate influence on the two innovation measures. In summary, as those determined influencing factors are all correlated with three dependent variables, there is no need to eliminate any one of them.

5 Results

Our empirical analyses are divided into two aspects—the first one is the investigation among five crowdsourcing-related factors on the whole through ordinary least-squares regression and the second one is the influence of these factors on firms' growth opportunity. The regression results are presented in Table 4. The adjusted R squares in Table 4 indicate that all of the five independent variables explain 6.1% of innovation and 2.7% of patent-related activities.

Hypothesis 1 (H_1) assumes the positive relationship between crowdfunding and both the innovation proxies.

As indicated in Table 4, crowdfunding is negatively related to innovation (model I) with statistical significance (-1.13) but in the patents model (model II), the relationship is negative without significance (-0.56). In short, the negative relationship exists in two innovation measures and crowdfunding, disconfirming H_1 . Interestingly, these findings contradict Paschen (2017) and Stanko and Henard (2016) who posited that crowdfunding leads to an increase in innovation, through increased idea generation and feedback from backers (i.e., the wisdom-of-crowd effect). Likewise, Walthoff-Borm et al. (2018) had earlier found that the ECF firms made 3.4 times more patent applications than matched non-ECF firms. The second row in Table 4 reflects the influence of age on innovation and patents. The coefficient of age with innovation is positive and non-significant, while the magnitude of its economic effect is 4.03.

This result follows the agency theory which indicates that firms are able to reduce information asymmetries between investors and managers over time (Fama and Jensen 1983). This is also important as Ahlers et al. (2015) and others have argued that information asymmetries prevalent in equity investments may exacerbate adverse selection risk for investors in young firms. The relationship between technology companies and patents is positive but not significant. From the perspective of a technology company strategy, innovation-related activities are essentially their core operations and must be performed to retain their competitive position in the market (Hall and Lerner 2012). However, it is not necessary for them to patent all their innovations. Consequently, considering the innovative nature and flexibility of their operations, the positive effect of innovation is tenable but not obvious in the patent model. In addition, there is a notable positive correlation between seed funding and innovation while the economic magnitude of the effect is 0.970 (the corresponding coefficient is 16.58 and is statistically significant at the 10% level*). According to the statistics in Table 4, there is an adverse association of VC to innovation and patents with the coefficient values of -0.24 and -0.11 , respectively. In theory, they support the crowdfunding literature which indicates that, from the perspective of the firm, social financing is superior to venture finance.

As a result, SME firms are able to rely more on ECF financing but meanwhile decrease the dependence on venture capital. In this section, the last hypothesis we

Table 2 Pearson correlations

	Mean	Std dev	Innovation	Patent	GO	CROWDF	AGE	TECH	SEED	VC	MGT
Innovation	0.42	0.37	1								
Patent	7.18	7.25	.21	1							
GO	0.78	0.71	.071	.071	1						
CROWDF	0.51	0.53	.093	.061**	.374**	1					
AGE	3.75	3.81	-.032	0.143**	.169**	.017	1				
TECH	0.33	0.34	.156**	-0.237**	.067	.171**	.080	1			
SEED	0.26	0.24	-.002	.083	.029	-.063	.074	-.019	1		
VC	0.19	0.18	.003	.076	.123	-.004	.125	.167	.005	1	
MGT	0.3	0.23	.027**	0.001	.164**	.021	.147	.138**	.003	.026	1

**Correlation is significant at the 0.01 level (two-tailed)

test is the relationship between crowdfunding and SME growth opportunity. The influence of crowdfunding on the GO model is described next in Table 4; the model presents the estimates of OLS model predicting growth opportunity (model III). The coefficient of crowdfunding is positive and statistically significant, suggesting that crowdfunders are more likely to be associated with a SME that is pursuing a growth path. The association of crowdfunding to GO is statistically significant at the 1% level, supporting H₂. It is concluded that, compared to innovation, firms pursuing a growth strategy that offers flexibility and low cost are more likely to be influenced by crowdfunding. This is potentially due to the provision of crowdfunding funds as an enabler to invest in long-term research and development and capital, which will further propound growth in later stages of the SME life cycle—for instance, at the expansion stage. Similar to Hornuf et al.'s (2018) result, we also find that management team has a positive influence on the growth opportunity of SME firms, as the coefficient of management team is positive and statistically significant. Although Hornuf et al. (2018) are more concerned with the

question of follow-up equity crowdfunding campaigns and how they impact funding by outside BAs/VCs, our results suggest that SME management teams can play an important role in how new funds may be effectively utilized toward achieving growth and development.

We also checked for potential multicollinearity problems in the model. Per definition, when two variables have a correlation of 1 or -1, they measure the same thing; thus, multicollinearity occurs. To check multicollinearity, we implemented the “collinearity diagnostic” as part of the “coefficients” table. A VIF (variance inflation factor) value above 10 also suggests multicollinearity, and we found a low value of VIF. We calculated the VIF excluding the time dummy. Thus, in conclusion, all independent variables have correlations with the dependent variable but no multicollinearity exists (VIF = 1.190 for crowdfunding amount, 1.041 for firm age, 1.193 for technology firms, 1.036 for seed investment, 1.012 for VC firms, 1.191 for management teams). The first goal of this study was to explore the area of crowdfunding and its relationship with innovation and growth in the province of SMEs. As previously stated, hypothesis testing was

Table 3 Short-term market performance differences between equity crowdfunding and non-equity crowdfunding SMEs

Variable	Type	Minimum	Median	Sample size
ROA	Equity crowdfunding SMEs	0.03	0.01	230
	Non-equity crowdfunding SMEs	0.01	0.00	225
Age	Equity crowdfunding SMEs	0.31	3.81	230
	Non-equity crowdfunding SMEs	0.45	3.93	225
Firm assets	Equity crowdfunding SMEs	1.19	3.30	230
	Non-equity crowdfunding SMEs	1.34	5.97	225

Table 4 Estimated ordinary least-squares regression results

	Model I		Model II				Model III					
	β	SD	β	SD	T	Sig	T	Sig	β	SD	T	Sig
CROWDF	-1.136*	0.046	0.267***	0.067	1.563	0.000	-2.263	0.025	-0.564	0.043	-1.289	0.187
AGE	3.867	0.026	2.395	0.031	1.498	0.225	1.617	0.121	7.683***	0.024	-3.864	0.000
TECH	0.000	0.001	0.163	0.052	1.634	0.583	0.231	0.720	.003*	0.001	2.371	0.046
SEED	16.583*	0.071	0.138*	0.075	3.842	0.009	2.570	0.009	6.789	0.066	1.036	0.291
VC	-0.243	0.001	0.286	0.084	1.538	0.753	-0.426	0.653	-0.115	0.001	-0.242	0.752
MGT	1.531	0.036	0.156	0.053	1.376	0.482	1.387	0.325	1.789	0.078	1.378	0.462
(Constant)	-10.555	0.109	-11.677	0.126	-0.923	0.563	-0.965	0.335	53.473***	0.100	5.367	0.000
R^2	0.041				0.076				0.067			
Adjusted R square	0.061				0.027				0.048			
F	2.734*				5.398***				2.753*			
Regression SS	0.968				1.548				0.962			
Residual SS	21.173				17.372				21.387			

Model I dependent variable: innovation performance; model II dependent variable: patent grants; model III dependent variable: growth opportunity. Time dummies are included in all models. *, **, *** statistically significant at the 10%, 5%, and 1% level, respectively

undertaken to assess whether there is a relationship between crowdfunding and innovation, and between crowdfunding and GO. After performing OLS regression analysis, H_1 (use of crowdfunding by a SME will increase the level of innovation) was rejected and H_2 (use of crowdfunding by a SME will increase GO) was accepted, providing an indication on the role of crowdfunding and how it supports SMEs through the idea generation, provision of feedback from backers, and the subsequent impact on firm growth. Previous studies conducted by Paschen (2017) and Stanko and Henard (2016) concluded that crowdfunding affords a value proposition to SMEs, through enhancing a valuable organization base and also through non-monetary benefits such as learning from external feedback, leading to innovation; however, the results produced in this study do not verify this argument. On the other hand, we find support for the argument that, with GO used as a proxy for firm growth, the use of crowdfunding leads to an increase in firm growth, through a reduction in the cost of financing and the provision of knowledge from external backers. Combining the findings of previous studies (Ordanini et al. 2011; Estrin et al. 2018) and results of this study, we can determine that ECF does act as a catalyst for growth, thus confirming the impact of the wisdom-of-crowd effect (Polzin et al. 2017; Herve and Schwienbacher 2018). Per the principle of the wisdom-of-crowd, the crowd can solve problems or make

decisions with more wisdom than an individual (Schwienbacher and Larralde 2012).

We now shed light on the impact of crowdfunding on SME performance. In this section, our goal is simply to show that, like the above analysis, ECF plays a major role in how SMEs can achieve their performance-related goals. In this sense, our current analysis complements the OLS regression tests that are used to predict whether a company has been effective in achieving innovation-/growth opportunity-related considerations. Prior empirical studies have sometimes used both market-based measures and traditional accounting ratios as predictors of performance. We use return on assets (ROA) as our performance measure, which is the net income as a percentage of total assets. The regression model is as follows:

$$ROA_i = \beta_0 + \beta_1 CROWDF_{i,t} + \beta_2 AGE_{i,t} + \beta_3 TECH_{i,t} + \beta_4 SEED_{i,t} + \beta_5 VC_{i,t} + \epsilon \tag{2}$$

where CROWDF is the crowdfunding amount raised as a percentage of total equity (shareholders' funds plus money raised); AGE is the number of years in operation; TECH is set to one for firms operating in the technology sector; otherwise, it is zero; and SEED takes the value of one if a firm has received governmental seed investment; otherwise, it is zero. If the SME introduced a lead

investor (VC or angel), it takes the value of one; otherwise, it is zero; and ε is the error term.

From Table 5, it can be observed that crowdfunding has the largest coefficient value; this means the predictor makes the overwhelming contribution to describe the variance of the dependent variable. The economic magnitude of the effect (0.970) confirms this trend, as well as the contribution of the other independent variables. We thus find support for H₃. For age, the economic magnitude of the effect (19.665) shows the trend to be on an upward trajectory. Meanwhile, the independent variable VC has the smallest economic effect (0.074), which means venture capital has the weakest contribution to demonstrate the variance of the dependent variable. Continuing this analysis, the other independent variables with influence on ROA, in descending order, are seed and technology companies. The R square value of 0.262 (the adjusted R square value is 0.253) indicates that 26% of the variance in ROA can be explained by the combination of crowdfunding, age, technology company, seed funding, and venture capital.

When examining firm performance outcomes, endogeneity can be a potential concern, as crowdfunding investments are not randomly determined. We employed the following methodological approach to deal with the potential issue of endogeneity. It is likely that crowdfunding investments are made in SMEs that are perceived as less risky and having higher growth and better performance. We first implemented a propensity score-matching method to eliminate heterogeneities between firms with high and low crowdfunding. Accordingly, we pair-matched firms with high versus low crowdfunding, based on the following criteria: performance (proxied by ROA), firm age (i.e., years since incorporation), and firm assets (total assets). We re-ran Eq. (2) using the propensity score-matched sample to deal with potential heterogeneities between SMEs with high and low crowdfunding. The results are reported in Table 5 (model II). The estimated coefficient of the key explanatory variable, *crowdfunding*, remains positive and significant when it is lagged by t-1 years. These findings demonstrate that the results in model 1 are not driven by endogeneity or self-selection. In this procedure, we used crowdfunding as an explanatory variable which may have biased our results. We therefore created a new sample of non-ECF SMEs that matched our ECF SMEs on key firm dimensions (see Table 3). We used this control sample of non-ECF SMEs to test their characteristics against our ECF SME characteristics. However, for the tests to be

representative of a real environment each ECF SME had to be matched against a non-ECF SME. For choosing appropriate samples in empirical studies of VC/crowdfunding effects, many scholars prefer to use the paired comparison method by matching a sample group of VC/crowdfunded firms with another group of non-VC/crowdfunded firms as closely as possible by the firm characteristics and size. The paired comparison method or matching firm approach in VC research is mainly to give priority to similar operational scales and then divide enterprises by VC/crowdfunding backing and non-VC/crowdfunding backing.

Likewise, in this paper, based on the statistical stream in the previous part of the discussion, samples are divided into two comparison groups—namely the ECF SMEs and the non-ECF SMEs. We acquired matched SME data from fame, yielding a sample of 230 ECF SMEs and 225 non-ECF SMEs because it was not possible to find a good match for all ECF SMEs. To construct the matched sample, we first identified those firms that raised capital, but did not do so through ECF (i.e., non-ECF firms); that is these firms did not raise capital from Crowdcube or any other platform. We matched each ECF SME based on performance (proxied by ROA), firm age (i.e., years since incorporation), and firm assets (i.e., total assets) in the year of the first ECF campaign. Table 6 (model I for ECF SMEs and model II for non-ECF SMEs) reports our findings. The comparison results show that ECF firms have very different performance profiles from those of the non-ECF firms.

6 Conclusion

With the recent phenomenon of crowdfunding disrupting the financial ecosphere, this paper set out to understand the dynamics behind equity crowdfunding. More specifically, it aimed to understand the relationship between equity crowdfunding and innovation, equity crowdfunding and GO, and ultimately, whether equity crowdfunding acts as a catalyst for SME performance. By building on and extending the extant research on equity crowdfunding, we examine its role in SME financial and innovative performance. The presence of asymmetric information for funders in equity-based crowdfunding means that investors face a number of risks, which can translate into moral hazard or adverse selection problems (Ahlers et al. 2015). There are also risks for small funders as it is likely that small

Table 5 Performance regressions

	Model I				Model II			
	β	SD	<i>T</i>	Sig	β	SD	<i>T</i>	Sig
CROWDF	0.238***	0.054	1.284	0.000	0.267***	0.061	1.487	0.000
AGE	0.671***	0.041	2.672	0.000	0.221***	0.041	1.331	0.000
TECH	0.151	0.025	0.271	0.672	0.022	0.001	0.041	0.658
SEED	0.173*	0.086	1.362	0.007	5.816	0.041	0.167	0.441
VC	0.054	0.019	0.467	0.853	0.003*	0.031	1.245	0.583
MGT	0.136	0.049	0.372	0.629	0.026	0.047	1.179	0.486
(Constant)	- 11.873	0.263	- 0.872	0.489	- 10.648	0.284	- 0.623	0.487
<i>R</i> ²	0.262				0.251			
Adjusted R square	0.253				0.258			
F	2.483*				2.583*			
Regression SS	0.956				0.872			
Residual SS	22.583				18.637			

Models 1 and II dependent variables: return on assets (ROA). Time dummies are included in all models. *, **, *** statistically significant at the 10%, 5%, and 1% level, respectively

investors do not hold sufficient financial expertise or acumen to perform due diligence (Steinberg 2012). It is in this context that prior studies have examined insolvencies of successfully funded equity crowdfunding campaigns, follow-up funding and crowd exits (Signori and Vismara 2018; Hornuf et al. 2018). These studies included the role of particular project characteristics (e.g., the share of equity offered or disclosure of financial projections), nominee shareholder structures (Walthoff-Borm et al. 2018), and the size and education

of the management team and how they relate to the success of campaigns (Ahlers et al. 2015; Vismara 2016).

We provide new empirical evidence on the crowdfunding domain—specifically, the impact of crowdfunding as an alternative financing source on innovation and GO for UK SMEs in 2014–20. A variety of statistical tests, including OLS regression, were performed to test the hypotheses relating to SMEs’ innovation performance, SMEs’ granted patent, and SMEs’

Table 6 Propensity score and controlled firm-matching results

	Model I				Model II			
	β	SD	<i>T</i>	Sig	β	SD	<i>T</i>	Sig
AGE	0.223***	0.067	2.362	0.000	0.116***	0.056	1.539	0.000
Tech	0.167	0.018	0.189	0.542	0.034	0.001	0.028	0.673
Seed	0.163*	0.072	1.293	0.007	0.143	0.026	0.168	0.621
VC	0.028	0.023	0.427	0.562	0.001*	0.017	0.182	0.547
MGT	0.137	0.024	0.374	0.536	0.048	0.063	0.125	0.684
(Constant)	- 13.764	0.356	- 0.769	0.378	- 13.374	0.328	- 0.727	0.632
<i>R</i> ²	0.256				0.232			
Adjusted R square	0.249				0.247			
F	2.372*				2.138*			
Regression SS	0.968				0.843			
Residual SS	23.537				17.694			

Time dummies are included in all models. *, **, *** statistically significant at the 10%, 5% and 1% level, respectively

growth opportunity. The study conveys that equity crowdfunding has an observable impact on SMEs and, more specifically, on the level of GO within the firm. In accordance with the results, we can conclude that crowdfunding has a positive influence on growth opportunity; the evidence suggests that the level of GO within a firm will increase as crowdfunding increases. Conversely, the study rejects Paschen's (2017) and Stanko and Henard's (2016) findings that crowdfunding leads to an increase in the level of innovation of SMEs. Performance regression results provide further support for a positive impact of crowdfunding on SME performance. Moreover, we used propensity score-matching and controlled firm-matching methodologies to eliminate any unobserved factors which may simultaneously determine crowdfunding and SME performance. Our analysis has revealed that the wisdom-of-crowd effect can be found when firms successfully raise equity crowdfunding. As we documented earlier, there are several investor areas in which there is now convincing evidence that this effect exists, e.g., equity crowdfunding (Walthoff-Borm et al. 2018) and lending-based crowdfunding (Bruton et al. 2017). We further clarify the mechanism through which the wisdom-of-crowd effect prevails in the context of ECF. For instance, tapping the crowd for financial resources induces a spectrum of related processes between the entrepreneurs and the crowd that likely benefit the organization in realizing its market- and performance-related goals (Polzin et al. 2017). As information cascades allow for the speedy and costless transfer of knowledge from customers to the entrepreneurs in crowdfunding-related network situations (Estrin et al. 2018; Ordanini et al. 2011; Vismara 2018), the crowdfunding platforms may influence SME growth through their effects on product and brand development processes. As our findings show, SMEs can successfully exploit these effects when engaging with crowdfunding networks and stakeholders. The existence of such mechanisms ensures that SMEs can not only utilize ECF to overcome their financing constraints but also use it to exploit their growth opportunities and help achieve improved level of performance.

In this study, we determine whether equity crowdfunding impacts innovation and GO, and thus acting as a catalyst for SME growth. Our findings not only provide empirical evidence for the outcome of equity crowdfunding, but also reveal new insights into several ongoing debates in SME performance and the wider field of entrepreneurship. Thus, this paper can be

used as a basis for further study; it includes a host of additional variables to produce a more detailed model further clarifying the significance of crowdfunding in a SME-dominated economy (Cichy and Gradon 2015; Naudé 2010). As Cumming et al. (2019) suggest, problems such as adverse selection could be significantly reduced if firms that provide information on equity crowdfunding platforms represent the facts. SMEs can potentially benefit more by taking such an initiative as this will increase investor confidence in them and, consequently, pave the way for them to achieve more success in post-campaign relationships between entrepreneurs and investors. This can prove to be all the more significant as, otherwise, the surviving ECF firms could eventually develop into "empty shells" or "zombie firms," as Signori and Vismara (2018) earlier indicated. Finally, in terms of future research, with companies viewed as living organisms by many, it is not possible to capture all intrinsic characteristics of crowdfunding and its role in financing SME growth through a purely quantitative approach. A qualitative approach should also be taken in conjunction, as it would ensure that the essence of difficult concepts and measures, such as innovation, can be properly captured, thus resulting in a more reliable and comprehensive study.

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