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Fintech Startups in Germany: Firm Failure, Funding Success, and Innovation Capacity

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Abstract

Fintech startups have set out to revolutionize the financial world. However, little is known about how successful and innovative these firms actually are. This paper investigates firm failure, funding success, and innovation capacity using a hand-collected dataset of 892 German fintechs founded between 2000 and 2021. We find that founders with a business degree and entrepreneurial experience have a better chance of obtaining funding, while founder teams with science, technology, engineering, or mathematics backgrounds file more patents. Early third-party endorsements and foreign partnerships substantially increase firm survival. We also establish the following stylized facts: (1) fintechs focusing on business-to-business models and which position themselves as technical providers prove to be more effective; and (2) fintechs competing in segments traditionally reserved for banks are generally less successful and less innovative. These results have important implications for the early-stage success management of fintech firms and the investment decisions of venture capital funds and government startup programs.

JEL-Codes: G240, M130.

Keywords: Fintech industry, firm funding, firm failure, innovation capacity.

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1. Introduction

Over the past decade, traditional financial institutions have been confronted with financial technology firms (fintechs) targeting their most lucrative business segments. Fintechs frequently offer specific financial services without having to cover the full range of regulated financial services. They typically realize cost savings through digitalization and, due to their limited scope of application, often have to meet less stringent regulatory requirements than a traditional bank (Navaretti et al. 2018; Hornuf et al. 2021). Given these qualities, it is reasonable to expect that fintechs would have distinct advantages in the financial services industry (Porter 1980). In this paper, we analyze whether such expectations about the success of fintechs have actually been met. In particular, we examine the resources that act as key drivers of success and innovation for fintech startups.

We begin by examining the literature on the determinants of fintech startup formations. In a cross-country analysis, Haddad and Hornuf (2019) identify economic and technological factors that encourage entrepreneurs to create startups aiming to reinvent financial business models. They provide evidence that a well-developed economy and readily available access to venture capital (VC) are particularly important for the creation of fintechs. Market resources such as the number of secure internet servers, cell phone subscriptions, and available labor also have a positive impact. In a similar vein, Kolokas et al. (2022) argue that VC investors require a critical mass of fintech entrepreneurs in a country in order for them to actively contribute to the growth of fintech entrepreneurship.

Previous research has also investigated the impact of fintech startups on bank performance. Wang et al. (2021) apply a data envelope analysis and find that fintechs increase commercial banks' profitability and risk-control in China. Their findings are in line with those of Li et al. (2022), who show that fintech innovations reduce Chinese banks' risk-taking by improving their operating income and capital adequacy ratio, optimizing their operating performance, and enhancing their risk control capabilities. Banna et al. (2021) examine 534 banks from 24 countries belonging to the Organization of Islamic Cooperation and also find that higher levels of fintech-based financial inclusion reduce banks' risk-taking. Similarly, Haddad and Hornuf (2023) find a positive relationship between fintech startups and incumbent financial institutions' performance for the years 2005–2018, using a large sample of financial institutions from 87 countries. Nevertheless, these articles assess the

success of fintech business models only indirectly by examining the performance changes they have brought to traditional financial institutions.¹

Research on fintech success factors has also examined specific fintech market segments. Hornuf et al. (2018) examine follow-up funding and firm failure in equity crowdfunding in Germany and the UK. They demonstrate that German firms receiving equity crowdfunding stand a higher chance of obtaining follow-up funding through business angels or VCs but also have a higher likelihood of failure. Resources such as a higher number of senior managers and a higher number of initial VC investors have a positive impact on obtaining post-campaign financing, whereas a higher age of senior management team members has a negative impact. Furthermore, a higher number of initial VC investors and a higher valuation of the firm significantly increase the likelihood of firm failure. In contrast, a higher number of senior managers and a higher amount raised during previous equity crowdfunding campaigns have a negative impact. Signori and Vismara (2018) study the success of equity crowdfunding firms in the UK and find that resources such as the degree of investor participation and the qualifications of investors matter for firm success. They find that none of the firms initially backed by professional investors failed by the end of the sample period. Again, these articles only indirectly examine the success of fintech business models by examining the success of the firms financed by fintech platforms.

A growing literature examines differences in fintech success as a result of entrepreneurial efforts. For example, Gazel and Schwienbacher (2021) show that, for French entrepreneurs, the chances of a startup's success are improved by being founded in a fintech cluster with competitors and supporters nearby. Carbo-Valverde et al. (2022) examine the return on investment of 170 Spanish fintech firms, looking at average profitability until three years after the founding, and find that fintechs from incubators are profitable earlier than collaborations with banks and local clusters. Turki and Rieg (2023) study 105 fintechs from different European countries involved in 201 VC rounds and find higher sales returns after a VS round when founders have experience in finance and technology, while banking experience does not play a role. Werth et al. (2023) conduct a literature review to study the theoretically grounded predictors of fintech firm success. They find that the cost–benefit dynamic of the innovation; technology adoption; security, privacy, and transparency; user trust; user-perceived quality; and industry rivalry are among the most important factors for fintech success.

¹ For a literature review on collaboration between financial institutions and fintechs, see McKillop et al. (2020).

A growing number of research articles specifically examine the German fintech market. Stuckenberg and Leker (2019) use fintech accounting variables to predict firm failure. Based on a nine-year sample of 131 German fintechs, they show that the critical time point for failure typically occurs three to five years after a firm was founded. Based on a sample of 101 German fintech firms, Klein et al. (2020) provide empirical evidence that both human capital and strategic orientation have a positive impact on the attractiveness of a fintech for investors. A study by Kostin et al. (2022) compares 334 funding rounds of German fintechs with 109 funding rounds of Russian fintechs and finds that funding in Germany is faster and more transparent. However, there is little evidence of whether fintechs have successfully penetrated the financial markets and what resources they require on the entrepreneurial level to improve their chances of success.

Another relevant strand of literature concerns innovation in the financial industry. While the number of patents for financial formulas and methods has increased since the 1970s (Lerner 2002), research on financial patenting and innovation capacities has long been sparse (Frame & White 2004). Research has recently begun to examine the factors that promote innovation in the financial industry. Among the most important factors affecting the innovation capacity of financial institutions are: contract-based financial incentives for innovators (Manso 2011), analyst pressure (He & Tian 2013), dependence on external equity funding (Hsu et al. 2014), banking market competition (Cornaggia et al. 2015), access to external financing, educated managers, ownership structures, and the extent of exposure to foreign competition (Ayyagari et al. 2011). Importantly, financial innovation is positively related to bank growth, but also higher bank fragility and worse bank performance during periods of crisis (Beck et al. 2016).

Fintech firms have also become the focus of recent empirical research. Chen et al. (2019) study patent filings from 2003–2017 and find that blockchain and robo-advising are the most valuable innovation types for the financial sector, which is reflected in a change in firms' market capitalization. This finding thus indicates what type of fintech startups might be particularly successful. Wang et al. (2021) find financial innovativeness in China has generally increased as a consequence of fintech; however, there is little evidence as to whether fintech innovations are successful, how long it takes firms to innovate, or which resources promote innovation.

The present study contributes to the existing literature in several ways. First, we test established theories and, for the first time, bring together the analysis of fintech success factors and fintech innovation capacity. This allows us to distinguish between resources that contribute to the firm's success and those that improve its innovation capacity. In contrast to

previous studies that test the theoretical perspective of the resource-based view, we do not rely strictly on abstract balance sheet data (Stuckenberg & Leker 2019; Valverde et al. 2022), but rather focus on concrete resources in the hands of entrepreneurial decision-makers. In particular, we measure different theoretical concepts not with crude proxy variables, but with variables that are of more direct interest. For example, previous literature has used the city in which the company is located as an indicator of networks (Agrawal et al. 2015; Giudici et al. 2018), manager and founder age as an indicator of experience (Delmar & Shane 2000; Hornuf et al. 2018), and the number of founders as an indicator of founder team experience (Ahlers et al. 2015; Barbi & Mattioli 2019; Delmar & Shane 2000). We base our measure of networks on the partnerships the fintech has entered into, and for skills and professional experience we use the years of education and years of professional experience of the respective managers. In line with the current literature (Piva & Rossi-Lamastra 2018; Banerji & Reimer 2019; Song et al. 2021), we collect information from social networks to empirically operationalize theoretical concepts, thereby enhancing the validity of our results.

Second, our dataset is several times larger than those that have previously been used in the literature. While 131 German fintechs are examined by Stuckenberg and Leker (2019), 205 by Kostin et al. (2022), and 101 by Klein et al. (2020), our sample includes 892 fintechs and 254 first financing rounds. Our dataset is based on the German Central Bank's extensive and high-quality list of fintech firms (Dorfleitner et al. 2022). The dataset covers 22 years starting January 1, 2000. An advantage of this more comprehensive dataset is that our empirical analysis is much less prone to survivorship bias. Furthermore, we augment this dataset with hand-collected information from company and patent registers, historical company websites, social media profiles on platforms such as LinkedIn and Xing, web searches, and geolocation databases. We achieve much higher granularity than previous studies by using information from 1,264 resumes and over 13,514 historical web pages. The data also allows us to identify a specific fintech firm's market segment and positioning strategy. This extension of the original German Central Bank dataset consequently allows us to identify how fintech firm success and innovation capacity are distinctly impacted by the resources of the founders, of their networks, and of the firms themselves.

Third, strategic policy informed by a nuanced understanding of the factors driving fintech success and innovation capacity can contribute significantly to the growth and stability of the entrepreneurial finance market. In the case of Germany, improving the conditions for startups is particularly important because, although Germany is the fourth largest economy, it is only in 15th place when it comes to favorable conditions for startups (Global Entrepreneurship and Development Institute 2018). The lack of human and network

capital in particular has led to discussions about the need for political support for German startups (KfW Research 2018). This paper provides valuable insights to enrich such policy debates. For example, a policy targeting the long-term success of the fintech sector should make it easier for professionals with experience in the financial industry to start a fintech, as these types of founders have been proven to be significantly more successful than those with a purely entrepreneurial or technical background. Measures encouraging further innovation, on the other hand, should focus on supporting founders with science, technology, engineering, or mathematics (STEM) backgrounds. Our results also show that policies should prioritize early-stage support by encouraging third-party endorsements and international partnerships even before the formal establishment of the firm. Finally, for VC investors, we determine which resources they need to pay attention to in order to predict the failure of a fintech in the startup phase and to maximize the impact of their own resource allocation.

We find that publicly observable, nonfinancial, and intangible resources at the time of fintech founding can predict fintech performance and innovation in subsequent years. This is an important finding because fintechs often have no physical assets and it is difficult to conduct due diligence in the pre-seed and seed phases of a startup. We show that the general idea that human capital improves outcomes needs to be more nuanced. Founders with a business degree and entrepreneurial experience have a better chance of obtaining funding, while founder teams with STEM backgrounds file more patents. We also distinguish between firm and network resources and find that only particular network resources influence our outcome variables. Variables such as proximity to other firms or location in monopoly regions, which are often used in the literature, play less of a role when we consider concrete information about partnerships. We also provide some stylized facts about the disruptiveness of the fintech market. We show that fintechs perform worse when they target traditional financial services such as financing or wealth management, whereas fintechs providing complementary services such as IT infrastructure and alternative payment methods perform better and generate more innovations. Finally, fintech firms tend to perform better when they use more technology-oriented marketing language and portray themselves as less profit-oriented.

The remainder of this paper is organized as follows. The next section provides a brief overview of the German fintech industry. In Section 3, we describe the relevant theory and testable hypotheses. Section 4 presents the data and method. Section 5 outlines the empirical results and presents robustness checks. Section 6 concludes with managerial implications, limitations, and avenues for future research.

2. The German fintech sector

The Financial Stability Board of the Bank for International Settlements defines fintech as ‘technologically enabled financial innovation that could result in new business models, applications, processes, or products with an associated material effect on financial markets and institutions and the provision of financial services’ (European Banking Authority 2017, 4). This comprehensive definition extends to financial innovations by industrial firms, such as those in supply chain finance, or traditional financial institutions. The present study, however, is much more concerned with the new and less established fintech startups that have been founded in the past two decades, and particularly how they have established themselves in the market and whether they have indeed produced innovations.

While financial industry developments have been most pronounced in the United States (Rajan 2006), Germany is an interesting context for examining the success and innovation capacity of fintech firms. This is because in Germany, a country that has traditionally tended to be more bank-oriented, fintechs have the potential to create the most added value. If there is anywhere fintechs can reform the financial landscape and bring about innovations, it is probably in Germany, the land of Girocard and cash payments (Deutsche Bundesbank 2021). By analogy with the traditional value-adding areas of a universal bank, fintechs can be distinguished on the basis of their involvement in financing, asset management, payments, and other often more technical or regulatory activities. Below, we divide fintech into these segments, as they reflect, among other things, different market concentrations, success potential, and business models.

The fintech market in Germany has continued to grow dynamically in recent years. Dorfleitner and Hornuf (2023) have identified an annual growth of 28% over the years 2015–2021 for the financing and asset management segments. These two market segments reached a volume of €85.3 billion in 2021 alone. There is also VC financing in the German fintech sector, which amounted to €3.7 billion in 2021, but fell to €1.3 billion in 2022.² That amount seems comparatively small for Europe’s fourth largest economy, especially when compared to the \$92 billion in VC funding in fintech globally. Nevertheless, within Europe, Germany is still the second strongest market for VC financing in fintech after the UK.³ Whether this is sufficient to create successful and sustainable fintechs and bring about financial innovations is to be examined empirically in the present study.

² EY Startup-Barometer: <https://startup.ey.com/wp-content/uploads/2022/07/EY-Startup-Barometer-Juli-2022.pdf>

³ <https://www.innovatefinance.com/capital/fintech-investment-landscape-2022/>

3. Theory and hypotheses

3.1 Resource-based view

The theoretical concept we rely on to explain the entrepreneurial success and innovation capacity of fintechs is the resource-based view (Penrose 1959; for a review see Barney et al. 2001). The resource-based view is a theoretical framework from the strategic management and business strategy literature that focuses on the internal resources and capabilities of a firm as the primary sources of competitive advantage. The theory states that not all companies have equal access to resources and that companies gain a competitive advantage by exploiting unique and valuable resources that are difficult for competitors to obtain. Resources are the tangible and intangible assets that a firm possesses. In principle, these include physical assets (e.g., equipment, factories), human assets (e.g., skilled and experienced founders and employees), organizational assets (e.g., efficient processes and modern technology), and intangible assets (e.g., patents and trademarks). Because physical assets are rarely produced in the fintech sector,⁴ they are typically less relevant to a firm's success than human assets or organizational assets. We therefore focus on intangible resources as a driving force for fintech success and innovation, because the software they develop and the knowledge they require about the financial products are often intangible in nature.

Our theoretical approach is closely linked to human capital theory (Unger et al. 2011), which views people as assets or capital investments that can generate economic value for a company through their education, training, and experience. Our theoretical framework is also linked to the literature on organizational ecology (Brüderl et al. 1992), which views organizations as entities that compete for resources and survival within a dynamic and changing environment. We therefore differentiate resources according to their origin: the founders, their networks, or the firm. We first analyze these resources theoretically and then test their influence on fintech success and innovation capacity empirically.

Fintechs' digital services, such as the use of blockchain technology and generative artificial intelligence, are new in many ways and can lead to unexpected and atypical results in terms of the driving factors for fintech success and innovation capacity. Thus, our hypotheses about which specific resources are important for fintech success and innovation capacity, while based on established theoretical concepts, remain to some extent exploratory. Our approach is consistent with the findings of Jourdan et al.'s (2023) fintech literature

⁴ Exceptions include, for example, the production of point-of-sale payment devices or bitcoin mining hardware.

review, which finds that most cutting-edge fintech research is explanatory, primarily due to the nascency of fintech understanding.

3.2 Founder resources

In our setting, founder resources are primarily human capital resources. A meta-study by Unger et al. (2011) shows that human capital resources are generally the most important factors affecting the success of a startup firm. Ahlers et al. (2015) and Barbi and Mattioli (2019) show in the context of crowdfunding that human capital is a key factor for funding success. Theoretically, human capital is often associated with the number of founders. Delmar and Shane (2006) and Ahlers et al. (2015) argue that having more founders generally improves human capital, which leads to better problem solving because a larger team can more easily address multifaceted challenges using a broader range of skills. Larger founding teams are often quicker at making decisions and more specialized in their knowledge (Eisenhardt & Schoonhoven 1990). We thus expect the number of founders to have a positive effect on firm success and innovation capacity.

When it comes to a startup's funding success, founders' human capital resources are often viewed as an effective signal to VC fund managers. Human capital resources are therefore not only directly relevant to firm success, but also indirectly, as they promote another resource by attracting VC funding. However, founders who successfully signal their human capital can also attract other resources such as employees, partners, and customers. Besides the professional structure and processes of the organization, which the founders might have established, the commitment and skills of the founders are often crucial for attracting such resources (Zott & Huy 2007). McGee et al. (1995) argue that the professional experience of the management team is also generally important for the firm's success. When it comes to VC funding, older founders are generally viewed more favorably by VC fund managers (Johnson 1978) because young founders have less experience (Franke et al. 2008) and operate in a less stable human capital environment (Bjelland et al. 2011). Finally, Piva and Rossi-Lamastra (2018) suggest that empirical analyses should consider a broader range of more specific human capital resources, such as the particular education and entrepreneurial or professional experience founders or managers bring to the venture. Such resources have been shown to be related to the size of new technology-based firms (Colombo et al. 2004) and make radical innovation more likely (Marvel & Lumpkin 2007). We therefore hypothesize:

H1. Founders' human capital resources increase fintech firms' success (H1a) and innovation capacity (H1b).

Fintech business models are often interdisciplinary, combining finance, technology, and entrepreneurship. For a fintech startup to be successful, this interdisciplinarity should also be reflected in its human capital resources, possibly even more than in less interdisciplinary sectors. An unbalanced human capital portfolio in the founding team can potentially hold back entrepreneurship (Backes-Gellner & Moog 2013). This seems particularly likely for fintech startups because finance and technology have historically been quite different career paths and are not integrated in most universities. This raises the question of how these separate human capital resources can now be successfully linked together in fintechs. A literature review by Krieger (2018) shows that industry-specific human capital is rarely examined in the literature and, to our knowledge, has yet to be considered when examining the success of fintech companies. We therefore hypothesize:

H1 (continued). A wide variety of founder-team human capital related to financial and technological skills increases fintech firms' success (H1c) and innovation capacity (H1d).

3.3 Network resources

The resources that can be provided by the founders' networks have been extensively studied in the context of VC financing. VC fund managers often occupy a seat on the board of directors, helping the founders introduce business processes and practices (St-Pierre et al. 2011) and assisting in finding and hiring key employees (Gompers et al. 2020). External partners, such as venture capitalists, have also been shown to improve the knowledge acquisition of the venture (Fernhaber & Mcdougall-Covin 2009; Maula 2001), dynamic capabilities related to product and management development (Arthurs & Busenitz 2006), and the value creation process of the venture more generally (Bugl et al. 2022).

Connections to external stakeholders go beyond investors and can also include, for example, business partners or customers. In other cases, networks are built early through membership in an incubator or accelerator program (Chatterji et al. 2019). External stakeholders can support the venture through third-party endorsements, which carry weight and credibility as they could entail reputation costs for the supporting stakeholder if the endorsed firm fails. Such an endorsement might take the form of a support statement that is posted on the firm website. Because many fintech startups pursue business-to-consumer business models, contacts with customers can also be verified on third-party social media platforms, where customers may express their support.

Especially in the context of crowdfunding, it has been empirically shown that network resources are crucial for funding success (Colombo et al. 2014; Mollick 2014; Courtney et al. 2017; Vismara 2018). This is because networks generally reduce information asymmetries, signal the quality of ventures to third parties (Stuart et al. 1999; Gulati & Higgins 2003), and help attract human capital (Hellmann & Puri 2002). The empirical evidence further shows that network resources facilitate information diffusion (Zuckerman 1999) and foster innovation (Hsu 2006; Dutta & Folta 2016; Kortum & Lerner 2000). In the context of fintechs, networks on social media platforms can be crucial for startup success and the development of innovations (Muninger et al. 2019), for example when investor groups exchange information about stocks via chat groups or when posts on social media networks fuel activity on the fintech platform (Eisenbeiß et al. 2023).

Resources that promote fintech firm success and innovation capacity can also be obtained offline, particularly through a local partner network (Agrawal et al. 2015; Giudici et al. 2018; Hornuf et al. 2022; von Horn & Kudic 2023). Startups based in a metropolitan area also typically have better opportunities to learn from traditional financial institutions, their competitors, and potential customers (Boschma 2005; von Horn & Kudic 2023). The empirical evidence also shows that knowledge spillovers between firms decline rapidly with geographic distance (Argote et al. 1990; Jaffe et al. 1993). However, it is not just geographical proximity that matters for fintech success, but also network proximity; that is, how a fintech is integrated into the ecosystem of banks and fintechs (von Horn & Kudic 2023). On the other hand, local networks and industry clusters are not *per se* advantageous for startups (Dumais et al. 2002; Rosenthal & Strange 2003; Stuart & Sorenson 2003), because too much geographical proximity isolates innovators from external stimuli that are crucial for innovation (Bathelt et al. 2004; Gertler & Levitte 2005). Overall, we expect that network resources increase fintech firms' success and innovation capacity.

H2. Network resources increase fintech firms' success (H2a) and innovation capacity (H2b).

3.4 Firm resources

Not all of a fintech's resources are in the hands of the founders. Sometimes the fintech also holds resources as an independent legal entity. Enforceable rights are among such firm-specific resources that promote its performance and innovative strength. For example, patents and trademarks can offer protection and signal the innovation capacity of the firm (Block et al. 2014). Trademarks have been shown to influence the market value of large listed firms

(Greenhalgh & Rogers 2006; Sandner & Block 2011), foster business angel and VC funding (de Vries et al. 2017), promote innovation (Malmberg 2005; Mendonça et al. 2004; Farre-Mensa et al. 2020), and increase firm survival (Helmers & Rogers 2010). Empirical research has also shown that protection through patents leads to higher valuations and attracts equity funding and customer interest (Audretsch et al. 2012; Holgersson 2013; Zhou et al. 2016). Patents can have an effect that is distinct from that of trademarks (Grazzi et al. 2020) and increase the chances of firm survival by reducing the risk of bankruptcy while increasing the likelihood of voluntary exit through mergers or liquidation (Kato et al. 2022). Our analysis will therefore include trademarks and patent rights at the time the fintech was created.

Digitalization has increased the importance of the company website as a quality signal, communication hub, and customer acquisition tool. Well-designed websites indicate robust business models and reduced information asymmetry, which have a positive impact on firm success and its ability to innovate (Wells et al. 2011; Colombo et al. 2014; Mollick 2014; Bi et al. 2017). In sum, we expect that network resources increase fintech firms' success and innovation capacity.

H3. Firm resources increase fintech firms' success (H3a) and innovation capacity (H3b).

3.5 Market-based view

The resource-based view alone most likely does not reflect the reality of fintech business models. For a comprehensive strategic management perspective on fintechs, we therefore also examine differences in business model characteristics. In particular, we rely on the market-based view, which focuses on a firm's competitive advantage and performance through the lens of external market dynamics, including factors such as customer preferences, industry conditions, and competitive forces (e.g., Porter 1980). The market-based view also emphasizes the importance of aligning a company's strategies with market conditions to achieve success. Note that the institutional-based view (Peng et al. 2009; Chowdhury, et al. 2019) emphasizes the significance of formal and informal institutions, including government regulations, cultural norms, and societal practices, in shaping a firm's strategies and performance in global markets. Because we focus on the German fintech market, we do not adhere to the institutional-based view, except where variation within national rules might affect fintech success and innovation capacity.

Given the pronounced industry segment heterogeneity among fintechs (Gazel & Schwienbacher 2021; Dorfleitner et al. 2023), adopting the market-based view when

evaluating the success and innovative capacity of fintechs appears relevant. For example, the competitive landscape in payment services, which is characterized by network effects and high market concentration (e.g., Rochet & Tirole 2003; Armstrong 2006), could present greater market entry challenges than those faced by fintechs offering traditional banking services, such as annuity loans. Moreover, first movers often have the opportunity to establish a strong presence in the market before competitors can enter or build a strong brand (Lieberman & Montgomery 1988), which is why one should consider the timing of market entry. Government support can also protect certain fintech segments from competitive pressures (Han 2021), for example through access to financial support or regulatory sandboxes where some fintech companies can test their innovations in a controlled environment.

There are also differences in resource allocation between business-to-business and business-to-consumer fintechs (Cui & Qian 2022). Customer acquisition costs and profit margins are likely to differ greatly between these two types of fintechs. Communication with target customers can also be fundamentally different; for example, business-to-consumer fintechs are more likely to attract customers via social media, whereas business-to-business fintechs might directly communicate attractive offers such as lower transaction fees to their business consumers. Based on language expectancy theory (Burgoon et al. 2002), we assume that, especially for business-to-consumer fintechs, a company's website plays a crucial role in its success. A website can help build credibility and meet a target group's expectations for external visibility. Research shows that, for example, pro-social positioning can have positive effects (Dacin et al. 2011), particularly for the success of crowdfunding campaigns (Parhankangas & Renko 2017) and the willingness of customers to share their data (Hillebrand et al. 2023).

Finally, legal forms with limited liability often require that founders invest a certain minimum capital. A higher minimum capital can be a signal that a fintech's business model is aimed at high returns and is associated with higher risk (Stiglitz & Weiss 1981; Harhoff et al. 1998). At the same time, it could also signal a seriousness threshold that is negatively related to the failure of a company (Seibert 2007; Commission of the European Communities & Winter 2002; for the banking context, see Rochet 1992).

Fintechs identify and fulfil unmet needs in the financial market. For example, they may target customers that do not want to be served by a bank. Fintechs can address such

demand by using a more casual or pro-social tone in their public presence.⁵ Moreover, fintechs might address underserved segments, for example by addressing very technical aspects of finance, which were previously underserved in the market. For example, personal financial management tools have only recently allowed customers to view accounts from different banks in one interface.⁶ This strategic approach allows fintech firms to develop distinctive product-market offerings, which gives them a competitive advantage. As a result, fintechs that address specific market niches with innovative products not yet available in the financial ecosystem are more likely to thrive and secure funding. This strategic positioning might be expressed through a more tech-heavy business model.

H4. A strategic positioning in the market as a ‘non-bank’ increases a fintech firm’s chances of success.

4. Data and method

4.1 Data

Our study is based on a sample of 978 fintech firms that either operate in Germany, were founded in Germany, or both. The sample was established as of December 31, 2021, by Dorfleitner et al. (2022) on behalf of the German Central Bank and, due to their comprehensive methodological approach, is likely to be close to the entire population of German fintechs. To account for the theoretical concepts outlined above and in particular the dependent variables, we expand the dataset using hand-collected information about company characteristics from the Amadeus database, the Crunchbase database, the German company register and 17 European equivalents. To measure firms’ innovation capacity, we collected information on patent applications from the PATSTAT database of the European Patent Office. We also collect historical website descriptions, social media profiles, and geographic locations of the firms’ headquarters, among other data, for the construction of network variables (see Appendix Figure A1).

In our empirical analysis, we only consider firms that were founded after 2000 because we are primarily interested in the success and innovation capacity of newly founded fintech firms (21 fintechs excluded). From a more technical perspective, this approach also allows us to eliminate outliers in survival times. In addition, we require an entry in a company

⁵ If fintechs provide regulatory banking services, they also have a banking license and are therefore classified as a bank. However, fintechs can push their banking character somewhat into the background in external communications in order to maintain a different image.

⁶ In this area, fintechs only had an initial market advantage. Nowadays, almost all banks allow the integration of other accounts into their own interface.

register to ensure full coverage of company survival information (64 fintechs excluded). Finally, because we require all information at the time of founding, a historical website must be available on archive.org (1 fintech excluded). Based on these inclusion criteria, we obtain complete information for a total of 892 observations.

4.2 Variables

4.2.1 Dependent variables

Our empirical analysis makes use of six dependent variables. First, *firm failure* denotes whether a startup went into insolvency, was liquidated, or was dissolved. It equals 1 if the firm failed and 0 otherwise. This is probably the crudest measure of a fintech firm's success. The information comes from the German company register and the corresponding company registers in other European countries. Second, *funding by BA/VC* also serves as a measure of firm success. Blaseg and Hornuf (2023) evidence that the financing a company receives is most important in reducing the likelihood of firm failure and in increasing traffic to its website. For this reason, we consider *funding by BA/VC* as an alternative measure of firm success. This variable is a dummy variable that equals 1 if the respective firm received additional funding from business angels (BAs) or venture capital firms (VCs) after the founding date and 0 otherwise. To identify BAs and VCs, we checked the historical shareholder list in the Amadeus database, the Crunchbase database, and company registers for each fintech in our sample. We consider a shareholder of the company to be a BA if the respective shareholder is a natural person who has invested in at least two other firms.⁷ We consider the date of entry of the investor in the shareholder list to be the time of investment. Third, the variable *patent filing* operationalizes the fintech's innovation capacity and measures whether a patent application has been filed by the fintech. This variable is a dummy variable that has a value of 1 if the firm has filed a patent and 0 otherwise. Because patents can belong to both the founders and the firm itself, we searched the PATSTAT database for company names and founder names. We exclude founder patents that have no apparent connection to the business model of the respective fintech startup.

⁷ Since there is no legal definition in Germany of what constitutes a BA, we consider private individuals on three or more shareholder lists to be BAs, especially because in Germany acquiring ownership of company shares requires a cumbersome transaction through a notary. We use this threshold to ensure that the individual is not a family or friend investor, actively engages in the investment community, and brings valuable experience, resources, and commitment to the companies they support. Our cutoff of at least three investments is not entirely arbitrary, as Agrawal et al. (2015) specify that family and friend investors invest in no more than three other projects, a measure which they validate empirically.

In a final step, we examine for all three dependent variables not only whether a *firm failure*, *funding by BA/VC*, or *patent filing* occurred, but also the exact timing of these events at time t after the firm's founding date, measured in months. For *time until firm failure*, we use the date of the announcement of bankruptcy or liquidation as the default event. The construction of *time until funding by BA/VC* and *time until patent filing* also follows this approach.

All dependent variables were constructed as of May 1, 2023. For the duration models, this is the time when right-censoring occurs. Appendix Table A1 reports variable definitions and describes the measurement of all variables in detail.

4.1.2 Explanatory variables

Founder resources. To test hypothesis H1, whether founders' human capital resources and their variety increase fintech firms' success and innovation capacity, we operationalize the founders' resources using various empirical measures. We created these variables based on hand-collected information from LinkedIn, Xing, historical company websites, a systematic internet search, and company registers. A frequently used measure of founder resources is the *number of founders*, which we construct from company registers and Dorfleitner et al.'s (2022) dataset. Identifying founders can be challenging, as their roles may overlap with managers and other positions within the company. To address this problem, we consider the founders to be the first natural people registered in the company register at the time of incorporation.

To address Piva and Rossi-Lamastra's (2018) call to consider a broader range of more specific human capital resources, we created several more detailed founder resource variables based on their resumes. In their literature review, Krieger et al. (2018) report on various measures of human capital heterogeneity that are used in empirical research. Most studies simply count the differences between founders on a single characteristic, such as the number of jobs, degrees, and demonstrated skills a team has. Similarly, we count experience among the specific resources that a fintech founding team has; i.e., financial, technological, and alternative education, and entrepreneurial and practical industry experience. Together, these factors cover a broad spectrum of human capital that a fintech may require to be successful. Our dataset allows us to track the years of study for each respective founder. We then calculate the average years of business-related education, which reflect the average length of education of the founders at the time of founding the fintech. We proceed similarly for average years of founders' education in STEM fields and alternative education. STEM fields

include science, technology, engineering, and mathematics-related disciplines. To take different educational backgrounds into account, we created the variables *business education*, *STEM education*, and *alternative education*,⁸ which are all based on founders' resumes.

To capture the founders' skills acquired through work experience, we track the experience founders had prior to founding the focal fintech startup. We split founders' work experience into average years of *entrepreneurial experience* and the catch-all category of average years of *professional experience*, which summarizes the remaining work experience. We systematically search the founders' resumes for items that indicate previous experience as a founder or co-founder, using the keywords listed in Appendix Table A2. We then calculate an average value for the founding team, which is often highly heterogeneous in terms of professional experience.⁹

Network resources. To test hypothesis H2, whether network resources increase fintech firms' success and innovation capacity, we study various professional supporters that the startup has access to. A startup can, for example, be founded by an already existing legal entity that can provide access to its resources, giving the respective fintech an advantage over founders without such professional support. This type of startup formation takes place, for example, through a spin-off from a company that operates an innovation lab or startup hub. This variation is captured by the variable *legal entity among founders*, which is a dummy variable equal to 1 if the fintech had another operating firm among its founders and 0 otherwise.

Network resources can also be provided by a partner who is not a founder, such as through a third-party endorsement. The variable *third-party endorsement* is a dummy variable equal to 1 if firm websites show more than one endorsement around the founding date and 0 otherwise. To create this variable, we downloaded 15 core webpages from the company website for each fintech around the founding date via archive.org. We identified the most important webpages for each fintech based on the length of the linking URLs, which capture the most important subpages and always include the landing page. We have identified endorsements through a keyword search for terms, such as 'partners' and 'sponsorship.' Appendix Table A2 provides a full list of the keywords we searched for.

We capture network effects associated with geographic proximity using the variable *metropolitan area*, which is a dummy equal to 1 if the firm is located in a city with more than

⁸ *Alternative education* considers every entry that founders have listed under education on LinkedIn. For example, training to become a bank clerk also falls under *alternative education*.

⁹ In 10 cases, in which a fintech firm was founded solely by a legal entity, we mean-replace the human capital values.

one million inhabitants and 0 otherwise. Since the proximity to banks and other fintechs varies for each fintech, we consider the variables *bank density* and *fintech density*, which measure the logarithmic average distance to the 50 nearest banks and the 50 nearest fintechs, respectively. We obtained the addresses and geolocations of the fintechs' headquarters from BvD Amadeus and openstreetmap.org.

Finally, because contacts to a follower or customer network can provide helpful resources to the fintech startup, we measure if the respective fintech's early website included links to social media platforms. To ensure that the fintech is not just minimally engaged in social media but is actively participating in the social media ecosystem, we required that the fintech's website link to social media websites at least three times around the founding date. In such cases, the *firm social media presence* dummy takes the value 1 and 0 otherwise. One or two social media links might indicate *ad hoc* social media engagement, while links to more social media webpages indicate a more sophisticated multichannel effort, potentially reflecting a strategic social media presence by the fintech firm.

Firm resources. To test H3, whether firm resources increase fintech firm success and innovation capacity, we consider important legal rights a firm possesses as well as its product quality. *Registered trademarks* and *registered patents* are, respectively, the total number of trademarks and patents that showed up in the patent register within the first 12 months after the founding date of the fintech. Due to the time required for legal registration, these patent applications were most likely filed around the time of incorporation, which means that the founders expected the resources to be available at the time of incorporation. To operationalize website quality, we measure the website size, that is, the total number of words on the 15 most relevant webpages of the focal fintech around the founding date on a logarithmic scale.

The independence of the firm's resources from its foreign operating parent is captured by *foreign branch*. A firm's dependence on a corporate group or another foreign company suggests that additional resources through licenses or human capital can, for example, be provided by the parent company. The dummy variable is equal to 1 if the fintech is an independent startup, while a value of 0 indicates that the focal fintech is a spin-off of an existing corporate group or fintech operating abroad.¹⁰ Note that all explanatory variables

¹⁰ One might argue that we should consider the initial financial resources of the fintech in our empirical model. However, due to their limited external observability, the often implicit nature of financial contracts, and entrepreneurs' strategic reporting of assets and collateral, initial financial resources are of little empirical value in determining a company's success and innovation capacity. Nevertheless, in a mediation analysis, we use the outcome of venture capital injections as a measure for financial resources to take a first look at the impact of financial resources on our outcome variables. Moreover, due to unreliable data, it is difficult to determine the initial employees of fintech startups. However, the number of founders and the

take their measurement from before or concurrent with the fintechs' incorporation, ensuring that they reflect conditions prior to the start of the survival period.¹¹

Market positioning. To test H4, whether a fintech positions itself as a 'non-bank' in the market (i.e., how the fintech communicates to attract customers), we measure the tone used on the website. The percentage of predominantly financial or technical words results in the variables *finance tone* and *tech tone*. If the fintech uses at least five donation-related words on the website, the binary variable *pro-social tone* indicates whether a fintech is likely to be perceived more as pro-social. The variables measuring tonality are constructed using keyword matching with the words listed in Appendix Table A2. Moreover, to consider a fintech's target customer group, we use the binary indicator *B2B*, which measures whether the fintech offers a business-to-business service or not. The legal form of a fintech reflects its future strategic orientation, which we measure using *limited liability*, a dummy variable that is 1 if the firm incorporated as a limited liability company and 0 otherwise.

4.2.3 Control variables

To mitigate potential bias due to missing variables, we consider several control variables. Because founder age might affect the funding decisions of VC fund managers and consequently firm failure (Johnson 1978; Franke et al. 2008; Bjelland et al. 2011), we also control for the demographics of the founders. The variable *founder age* is the average age of the founders at the time the respective fintech was founded. Furthermore, the gender of the founder can make founding a firm and obtaining BA or VC financing more or less difficult (Wilson et al. 2007; Gupta et al. 2009; Zandberg 2021). We therefore record the gender of the founders based on their first name and express it as *percentage of males*. The information on founder names comes from various sources, such as the Amadeus database and social media platforms.

We categorize firm control variables, which are primarily related to the market-based view, on the basis of the fintech's business segment, the fintech's target customer group, and the general positioning of the fintech. To identify the fintech segment, we use the classification of Dorfleitner et al. (2022), which distinguishes four fintech segments: *asset*

establishment of legal entities and foreign branches are most likely a good proxy for the number of initial employees.

¹¹ Trademarks may experience delays in registration and website archives may be recorded irregularly. However, the data was generally collected around the date of incorporation and, in rare cases, within 12 months after incorporation. No bias is expected due to these delays, as no fintech failure or financing occurs during this time frame in our dataset.

management, financing, payments, and other fintechs. Other fintechs is a catch-all category and includes IT infrastructure, search engines, and insurance services. These four segments can be further classified into 17 fintech sub-segments (Dorfleitner et al. 2022). The *competitive strength* of a fintech is the Herfindahl–Hirschman Index (HHI) for a symmetric market structure at its founding date, that is, 1 divided by the total number of fintechs in the respective sub-segment at the time the startup was founded. The variable *competitive strength* thus indicates how strongly market power is distributed among a few companies. The variable captures the market dominance and first mover advantage of a fintech firm.

4.3 Method

The main goal of this study is to evaluate which resources contribute to building successful fintech firms. We therefore analyze the impact of resources of the founders and the company on firm failure, firm funding, and patent filings. All analyses are carried out at the firm level. Our observation period starts at the founding date of the fintech and lasts until firm failure, firm funding, patent filing, or right-censoring as of May 1, 2023.

We begin by estimating probit models that identify factors influencing the probability of *whether* a startup fails, receives funding from a BA/VC, or files a patent application. Coefficients reported are average marginal effects. The probit regression model takes the following form:

$$Prob[Failure_i = 1] = \Phi(\beta_1^T \mathbf{Founder Resources}_i + \beta_2^T \mathbf{Network Resources}_i + \beta_3^T \mathbf{Firm Resources}_i + \beta_4^T \mathbf{Controls}_i), \quad (1)$$

where i refers to the respective fintech, **Founder Resources** $_i$ is a vector of the founder resource variables such as *education* and *job experience*, **Network Resources** $_i$ is a vector of the network resource variables such as *third-party endorsement* and *fintech density*, **Firm Resources** $_i$ is a vector of the firm resource variables such as *registered trademarks* and *registered patents*, and **Controls** $_i$ is a vector of control variables including market-based variables, founder demographics, and segment and founding year dummies.

Second, we respectively examine *when* the startup fails, receives funding from a BA/VC, or files a patent application by estimating Cox proportional hazards models. Coefficients reported are hazard ratios. The advantage of the Cox proportional hazards model is that it does not require the specification of the time dependence distribution of the hazard.

The model also allows for right-censored data and time-varying explanatory variables. The Cox model takes the following form:

$$h_i(t) = h_0(t) \times \exp(\beta_1^\top \textbf{Founder Resources}_i + \beta_2^\top \textbf{Network Resources}_i + \beta_3^\top \textbf{Firm Resources}_i + \beta_4^\top \textbf{Controls}_i) \quad (2)$$

where t indicates the survival time and $h(t)$ is the hazard function defined by the set of covariates.

Third, to mitigate potential biases in estimating time-to-event outcomes, we also employ frailty models (Vaupel et al. 1979), which have also recently been used in the entrepreneurial finance literature (Dombrowski et al. 2023; Momtaz 2021). A problem in empirical entrepreneurial finance research is that scholars want to arrive at a general explanation for heterogeneity among fintech startups independent of latent clusters (Momtaz 2021). Comparisons with hazard ratios require an interchangeability assumption to hold, namely that any two observations that are compared from different clusters *ceteris paribus* yield identical results. If the set of observable variables is insufficient to establish this *ceteris paribus* condition, the interchangeability assumption is not satisfied and biases in the estimates occur. Unfortunately, this is likely the case when determining fintech success. A fintech in the payments segment might suffer a failure faster than an otherwise identical fintech in the financing segment due to various unobserved segment-specific confounders such as more severe network effects. The same reasoning also applies for the founding date in recessions versus boom periods of the business cycle. While an OLS setting can address unobserved heterogeneity with fixed effects, complicated biases can arise in time-to-event outcome variables where some observations leave the dataset after an event but their counterpart from another cluster remains at risk. Frailty models offer a more robust estimation approach compared to Cox proportional hazards models with and without fixed effects, allowing us to properly account for unobserved heterogeneity in cluster j (Momtaz 2021). To address challenges related to the functional form of the random effect, we consider both Gaussian and gamma distributions. Regardless of the model used, we report robust standard errors accounting for segment-specific effects.

$$h_{ij}(t) = h_0(t) \times \exp(\beta_1^\top \textbf{Founder Resources}_{ij} + \beta_2^\top \textbf{Network Resources}_{ij} + \beta_3^\top \textbf{Firm Resources}_{ij} + \beta_4^\top \textbf{Controls}_{ij} + \alpha_j). \quad (3)$$

5. Results

5.1 Descriptive statistics

Table 1 presents summary statistics. From our sample of 892 fintechs, 254 firms (28.5%) successfully secured funding, 163 firms (18.3%) experienced failure, and 34 firms (3.8%) have registered at least one patent.¹² The average time-to-event for all three events ranges from 93 to 105 months.

On average, founder teams consist of 1.81 founders. Founders tend to be predominantly male and around 35 years old, indicating a relatively young entrepreneurial cohort compared to the average age of 43 for senior managers in the domain of equity crowdfunding (Hornuf et al. 2021). With regard to education and professional experience, the data shows a high degree of heterogeneity. While STEM education is rare among founders, many founders have already garnered extensive professional experience in the financial industry or the technology sector. Just over half of the firms are located in metropolitan areas. In total, 4.1% had registered trademarks when they were founded, and 1.5% had registered patents. We find that 14.7% of the websites reference third-party endorsements. On average, a website consists of 8,973 words and 60.1% link to social media platforms. Finally, 13.3% of these websites use pro-social language and 1.6% of all words are financial terms. In contrast, technical terms constitute only 0.2% of the total word count. Appendix Table A3 shows Pearson correlations for all dependent and explanatory variables. The correlation coefficients are generally low, so multicollinearity is not an issue.

[Table 1 around here]

5.2 Firm failure

In this section, we present the regression results pertaining to the resources influencing firm failure. Our analysis begins with a binary outcome framework, which is followed by the survival analysis. Table 2 presents the results. Column 1 shows the results of the probit regression from Equation (1), and columns (2) to (5) present the outcomes of the survival analyses from Equations (2) and (3), respectively. The hazard ratios can be interpreted as the hazard of firm failure at one level of the explanatory variable relative to the hazard of firm failure if the explanatory variable is one unit larger. They represent

¹² Fintech patents pertain to concepts as diverse as cash dispensing, virtual cards, lease management, secure payments, authentication, and mirror trading, among others.

multiplicative effects or semi-elasticities, meaning that estimates below 1 represent negative effects, while estimates above 1 reveal a positive relationship.

[Table 2 around here]

When examining H1a, which states that founders' human capital resources increase fintech firms' success, we find that *professional experience* is negatively related to *firm failure*. As the probit regression in Table 2 column (1) shows, *professional experience* is statistically significant at the 5% level. One additional year of professional experience of the founder team is associated with a 0.75% lower chance of *firm failure*.

We find little support for H2a, that network resources increase fintech firms' success. In the probit regression, the variable *third-party endorsement* is weakly significant at the 10% level and indicates that an additional endorsement decreases the probability of firm failure by 6.87%. Other variables measuring network resources—*legal entity among founders* and *firm social media presence*—do not significantly change the likelihood of *firm failure*. The same applies for density measures for banks and fintech firms.

We find some support for H3a, which posits that firm resources increase fintech firms' success. Our findings suggest that a more sophisticated *website size* at the founding date and being a *foreign branch* are negatively related to *firm failure*, which is in line with our theoretical conjectures. With regard to *foreign branch*, fintechs that can rely on resources provided by a foreign parent company exhibit a 14.70% lower chance of failure, which is significant at a 1% level. Moreover, a more sophisticated website serves as a valuable resource related to a fintech firm's survival; doubling the website word count decreases firm failure by 2.79%, which is significant at a 5% level.

[Figure 1 around here]

Figure 1 reports the Kaplan–Meier estimates of the survival rates of German fintechs. The estimates reveal a relatively stable survival pattern within the first 50 months. Subsequently, there is a consistent downward trend until approximately 150 months after the founding date, at which point the survival curve plateaus. However, around 180 months after the founding date, the curve resumes its decline, accompanied by a notable widening of the confidence bands.

The results of the duration models are similar to the probit model. Across the duration models in columns (2) to (5), we find that, in line with H1a, *professional experience*

consistently demonstrates a negative, highly significant impact on firm failure. An increase in professional work experience of the founder team by one year reduces the hazard of failure by 5.30%.

The duration analysis also supports the network resource hypothesis. In the proportional hazards model, *third-party endorsement* leads to highly significant results, while in the frailty models the results are also weakly significant. The effect size is quite substantial, as one additional endorsement reduces the probability of failure by up to 39% in the proportional hazards and frailty models.

Finally, in the survival analysis we again find strong support for H3a. The *foreign branch* coefficient is consistently significant and indicates that a fintech founded as a foreign branch is around two-thirds less likely to fail than an independent fintech. This finding holds across all model specifications. *Website size* is no longer significant in the frailty models, suggesting a correlation of this variable with unobserved heterogeneity between fintech segments.

5.3 Funding by BA/VC

We now analyze the resources that help a fintech secure funding by a BA/VC. Table 3 column (1) presents the probit model, and columns (2) to (5) present the duration models. H1a posits that more human capital resources will lead to increased BA/VC funding. In all estimates, the *entrepreneurial experience* variable is statistically significant at least at a 5% level. The estimated coefficient suggests that an additional year of entrepreneurial experience in the founder team increases the probability of securing funding from an external BA/VC investor by approximately 0.77%. With respect to hypothesis H2a, which concerns the effect of network resources, our empirical analysis reveals a significantly negative coefficient for the variable *fintech density*. This result suggests that fintech firms located near other fintech firms are less likely to receive BA/VC funding. Regarding hypothesis H3a, which states that a fintech firm's resources have an impact on its performance, we find some evidence to support our theoretical prediction. In particular, the *number of registered trademarks* has a consistently positive effect. One additional trademark increases the likelihood of *funding by BA/VC* by 16.53%. This finding aligns with the notion put forth by Rujas (1999) that trademarks are an important form of protection that also enhance investor confidence and increase the likelihood of obtaining funding.

[Table 3 around here]

To examine the duration until a firm receives funding from a BA/VC, we again employ a duration analysis framework. Figure 2 displays the Nelson–Aalen estimates. Our findings indicate that the hazard to receive funding exhibits its highest increase during the first 40 months and generally displays a concave shape. After the first 40 months, the hazard rate gradually decreases, indicating a reduced probability of obtaining funding for a large number of fintech firms.

Consistent with H1a, we find that *business education* has a statistically significant effect. The probability of BA/VC funding increases with one additional year of business education by around 4.42% across all duration models. We also observe that both *entrepreneurial experience* and *professional experience* increase the probability of BA/VC funding. Each additional year of entrepreneurial or professional experience is associated with a 2.48 to 3.69% higher probability of receiving BA/VC funding. More founders in a fintech team increase the likelihood of BA/VC funding in only some frailty models, suggesting the presence of latent segment-level variation. Although other fields of study, such as *STEM education* or *alternative education*, and previous professional experience exhibit a positive relationship with BA/VC funding as suggested by H1a, they fail to achieve statistical significance in predicting the duration until funding.

Regarding human capital heterogeneity, we find that *business education* and *entrepreneurial experience* significantly improve a firm's ability to secure early-stage funding. In addition, long-term survival depends more on previous *professional experience* of the founder team. Success therefore depends on three human capital variables, which is consistent with H1c. While human capital in the areas of finance and technology is associated with positive outcomes, other forms of education, as measured by alternative education, have no impact. This means that, although the heterogeneity of human capital can be an advantage, it is not arbitrary.

When examining the impact of network resources on BA/VC funding, we find the directions of coefficients consistent with our network resource hypothesis but with low or no statistical significances. An exception is *fintech density*, which shows, in line with the probit model, that fintechs that are closer to other fintechs receive less funding. Therefore, we cannot completely reject the network hypothesis based on our empirical findings for BA/VC funding.

We find further support for the importance of firm resources in the lead-up to BA/VC funding. In particular, the duration models show a statistically significant and economically sizeable effect for each additional registered trademark and highlight the importance of

intellectual property protection as a valuable resource for fintech firms seeking external investment.

[Figure 2 around here]

5.4 Patent filing

In this section, we focus on the resources that enable a fintech company to successfully file its first patent. The Nelson–Aalen estimates in Figure 3 highlight a gradual and relatively modest upward trajectory of the likelihood of patent filings over time.

[Figure 3 around here]

The results in Table 4, based on equations (1) to (3), reveal that most variables are statistically insignificant, except for *STEM education* and some control variables. It seems intuitive that STEM education is linked to patent applications. A STEM education in the founder team relates to up to a 12% higher likelihood of patent filings. Finally, while human capital heterogeneity positively affects fintech success, we do not observe similar evidence for innovation capacity. Education in STEM subjects is crucial for innovation capacity, but cannot be supplemented by other financial knowledge or professional experience in this field.

[Table 4 around here]

Overall, innovations in the form of patents are hard to predict in our sample. The low significance levels may highlight the challenge of identifying innovations in software-oriented industries like fintech. First, it is generally difficult to obtain patents for software, which statistically leads to innovations being underestimated. According to Article 52(2) and (3) European Patent Convention, software is only patentable if there is a clear connection between software and hardware and establishing this connection is often not trivial, frequently requiring case-by-case examination by the patent office (Laub 2006). Nevertheless, differences in innovation capacity can be explained by potentially unobserved factors hidden in fintech segments, as we highlight in the section on stylized facts. Second, the ability to innovate could also be statistically overestimated due to low quality patents. Using patent citations as an indicator of patent quality helps to evaluate this effect. We find 22 citations for 10 of the 34 patents fintechs filed for. In addition, in 2024, a total of 12 of the patents were still pending and 22 were revoked after they were granted, indicating potentially

low patent quality.¹³ Such low patent quality is consistent with previous studies by Lerner et al. (2015).¹⁴

5.5 Market-based view and stylized facts of fintech markets

In addition to the resource-based explanatory variables of interest, founder demographics and market-based variables serve as controls in our empirical analysis. In Tables 2 and 3, we find that founder demographics impact fintech success. One additional year in *founder age* corresponds to an increase of the likelihood of *funding by BA/VC* by 1% or 4.27% in the duration models. Our results suggest that *founder age* has a negative effect, probably because young founders have higher productivity and talent for the *ceteris paribus* same amount of human capital to prevent business failure and attract investors.

Regarding the market-based view, we find that *competitive strength* decreases the chance of obtaining *funding by BA/VC* by 3.65%.¹⁵ However, contrary to the common belief that a first-mover advantage is an important factor for survival, *competitive strength* is statistically insignificant in predicting the chances of survival, while *competition strength* increases the time it takes for fintech firms to obtain funding in the period after the 2008 financial crisis. A *pro-social tone* strongly predicts *firm failure* and *patent filing*. Table 2 shows that fintechs that market themselves as pro-social are almost twice as likely to fail, which contradicts H4. In contrast, Table 4 shows these companies are three times more likely to file a patent. However, a pro-social tone does not attract outside investors. Fintechs founded as *limited liabilities* are up to five times more likely to acquire investment from BAs/VCS and tend to fail less frequently. This aligns with the economic rationale that the legal form and minimum capital are signals of the seriousness of the founders to the BAs/VCS. Regarding tonality, *tech tone* helps in receiving funding by BAs/VCS and correlates with a 9.18% lower probability of firm failure. With respect to self-promotion, it is worthwhile for fintech startups to present themselves as technical, which seems to match the general preferences of BAs/VCS and is in line with H4.

¹³ For comparison, we searched the patent database lens.org for all patent applications in Germany since 2000. We found a total of 11,448 patents. Of these patents, 64.4% were cited at least once. Each patent was cited an average of 3.65 times. Both figures are only about half as high for the fintechs in our sample.

¹⁴ Lerner et al. (2015) find that financial patents often cite fewer non-patent and academic publications compared to other patents, raising concerns about their quality. While the study does not establish a direct link between these quality issues and entrepreneurial success, it does suggest that weaker patents, more frequently litigated in court, may hinder innovation and competition in the financial sector.

¹⁵ The hazard ratio is the ratio between the probability of a financing event occurring for a monopoly firm (*competitive strength* = 1) and the probability of a financing event occurring for a firm in a polypole (*competitive strength* = 0). A hazard ratio of 0.9635 means that the probability of obtaining financing is reduced by $1 - 0.9635 = 3.65\%$ for the monopolist versus the otherwise identical control firm in the polypole.

We also report the segment dummies for all three dependent variables. Table 2 indicates that firm failure is relatively lower for the *other fintechs* segment. Similarly, Table 3 indicates relatively higher funding changes for the *other fintechs* and *payments* segments. Furthermore, Table 4 reports a relatively higher chance for patent filings in the *payments* and *other fintechs* segments, but lower patenting for the *financing* segment. In the *financing* segment, the probability of firm failure is 8.18% higher, the probability of obtaining BA/VC financing is 6.48% lower, and patent applications are 3.55% less common. The time until success is also significantly longer, which is reflected in higher failure rates and fewer chances of financing. In general, innovation comes faster from payments and other fintech segments, which are also funded more quickly than the more traditional asset management and financing sectors.

Although the institutional resources perspective is not our main focus, the division of Germany and subsequent reunification provides a unique framework to study institutional variation. Even more than 30 years after reunification, some institutional details still differ between East and West Germany (e.g., on average longer working hours, more working women, more childcare for children under 2 years of age) (Akcigit et al. 2023). We therefore include the dummy variable *East Germany* and examine its impact on our results in Table A4. We find 32.8% faster funding for East German fintechs compared to West German fintechs, even when excluding Berlin. This is in line with Achleitner et al. (2009), who evidence that discrimination by venture capital in East Germany is significantly lower than expected and strong public commitment has led to a relatively high share of VC investments in East Germany. In a similar vein, Sunley et al. (2005) assume that tailored government programs, which also exist in East Germany, motivate private financing. However, we cannot provide similar stylized facts for our results on survival or patenting.

6. Robustness checks

6.1 Alternative duration models

Appendix Table A5 presents alternative duration models such as the commonly used Cox proportional hazards, Gaussian, exponential, and Weibull models. The results show that many coefficients that are significant in the more traditional models lose significance in the frailty model, indicating the presence of unobserved heterogeneity captured by the frailty model. The existence of unobserved heterogeneity is not surprising in our context, because startup firms in particular often exhibit hidden characteristics that we cannot observe empirically. The results in Table A5 also demonstrate that, while the data quality and heterogeneity are sufficient to produce significant results in more commonly used models,

the insignificance of the frailty model coefficients can be attributed to the functional form in our analysis mitigating biases in time-to-event models (for an overview, see Momtaz 2021).¹⁶

6.2 Subsample analysis

As a robustness check, we exclude some rare observations with extremely long survival times and start our analysis with the year 2008 instead of 2000. Appendix Table A6 reports the results, which are consistent with those derived from the original samples presented in Tables 2–4. Results that are significant in Table 2 remain so throughout. Only for BA/VC funding do *business education* and *fintech density* lose significance, but all other previously significant variables remain statistically significant and economically important. Moreover, additional predictors now emerge for patent applications, including *larger teams* and the *B2B sector*, which predict a greater number of patents. A notable exception is the increase in the *competitive strength* coefficient. A one-percentage-point increase in *competitive strength* now leads to a lower probability of failure of up to 12.51%. Note that these effects relate mostly to the market-based view, indicating a changed market environment for fintechs after the financial crisis.

In Appendix Table A7, we use a more fine-grained set of 17 fintech sub-segments in place of the previous four segments, which allows us to better control for unobserved segment specifics. This alternation of fixed/random effects neither substantially nor qualitatively changes our findings.

6.3 Financial resources

An alternative explanation for our resource-based effects on *firm failure* could be the available financial resources, which often cannot be observed prior to the first BA/VC funding. However, the outcome variable *funding by BA/VC* measures financial resources and could act as a mediator for *firm failure*. Consequently, excluding *funding by BA/VC* from the model explaining *firm failure* may lead to an overestimation of the coefficients of the explanatory variables. This mediation concept is exemplified by Robb and Robinson (2014), who examine the capital structure choices of startups and discover that external debt plays a pivotal role in establishing sustainable businesses. By applying this insight to fintech startups, one could argue that securing capital through *funding by BA/VC* is vital for subsequent firm

¹⁶ Regarding alternative functional forms, we also conducted tests for nonlinearities in the human capital and proximity variables, as U-shaped behavior indicating an optimal range is theoretically possible. Because squared terms are already not statistically significant for the variables of interest, we can forego a deeper test for curvilinear effects (see, for example, Dombrowski et al. 2024; Monaco et al. 2024).

success. We therefore empirically investigate the conjecture that *funding by BA/VC* acts as mediator for *firm failure*.

The mediation analysis involves running three regression models. First, we regress the dependent variable *firm failure* on the explanatory variable x , where the significance of the regression coefficient of x is crucial (Table 2). If no significant relationship is observed between x and *firm failure*, the prerequisite for mediation is not met. Second, we regress the mediator variable *funding by BA/VC* on x (Table 3), where x should exhibit a significant effect. We find these two conditions to hold predominantly for *professional experience* and sometimes for *number of registered trademarks*, depending on the model. For each of these variables, we estimate a third and final model in which *firm failure* is regressed on both x and *funding by BA/VC*. To establish a mediation effect, the third model must exhibit a significant regression coefficient for *funding by BA/VC*, while the coefficient of x should be smaller than the one observed in the first model.

Appendix Table A8 presents the outcomes of the mediation analysis and highlights the average causal mediation effect and proportion mediated. To estimate the mediation models while accounting for additional covariates, we utilized a bootstrapping technique with 10,000 replications. Our findings indicate that the variable *number of registered trademarks* exhibits significant average causal mediation effects, contributing to a reduction in firm failures. Specifically, the number of registered trademarks mediates the relationship by approximately 50%. Consequently, the coefficients of *number of registered trademarks* reported in Table 2 are inflated due to the mediating effect of future funding. In other words, the estimates of the *number of registered trademarks* coefficient appear larger because it is not trademarks alone that contribute to the reduction in *firm failures*; rather, the *number of registered trademarks* serves as a signaling mechanism to attract BAs/VCs, resulting in improved survival prospects.

In contrast, *professional experience* does not exhibit a significant mediating effect. Thus, *professional experience* directly affects *firm failure*, without being mediated through *funding by BA/VC*. Finally, repeating the mediation analysis for *patent filings* as potentially mediated by funding, we do not find evidence of mediation effects.

6.4 Sample selection correction

As another robustness check, we account for sample selection as a result of limited data availability. Given our focus on founder resources, a potential sample selection bias could arise from limited founder data. Prior to examining factors such as firm failure, funding by BA/VC, and patent filing within the fintech industry, it is important to address the

determinants that lead to the availability of founder resource information. It is thus imperative to control for these factors when investigating fintech performance.

In cases where founders were not found on social media platforms, alternative means of obtaining data, such as internet searches, were implemented. However, when such founder data was not available at all, this resulted in missing values and a subsequent reduction in the dataset. To address the potential selection bias, we employ a Heckman correction model. This correction procedure involves two stages: the first stage analyzes determinants influencing the availability of social media information about a founder, while the second stage investigates the impact of explanatory variables on three outcome variables. Appendix Table A9 presents the results of the Heckman correction model.

For the first two dependent variables, *firm failure* and *funding by BA/VC*, we find that the inverse Mills ratio (IMR) is statistically insignificant, which indicates the absence of unobserved heterogeneity in the second stage. Hence, considering only observations where information on founders was available on social media platforms does not bias our results. When examining patent filings, we find a weak but significant correlation of the IMR in the second-stage regression, which suggests the presence of a selection bias. Even after the Heckman correction, however, we find a statistically significant and positive effect of *STEM education* on patent filings. A STEM education in the founder team now relates to an up to 15% higher likelihood of patent filings.

7. Conclusion

This paper examines how founder resources, their networks, and the resources of a fintech startup affect firm failure, encourage BA/VC funding, and influence patent filings. Our empirical analysis extends previous research on the success and innovation of fintechs in three ways.

First, we operationalize the strategic management perspective in the fintech industry. In particular, we provide an empirical perspective on detailed human capital, network, and firm resources that drive firm success and innovation capacity in the fintech domain. We focus solely on publicly available information at the time of starting a fintech company, such that external decision-makers such as BAs/VCs and potentially also generative artificial intelligence tools could predict its future operations. We also offer managerial implications to empower fintech startup companies from the outset. We show that diverse human capital resources are required to meet all needs: experience as an entrepreneur is essential for securing BA/VC funding, business training helps secure BA/VC funding more quickly but has no bearing on firm survival, and founders' STEM education correlates with patent

applications. The professional experience of the founders is universally important, as it contributes to the survival of the company and to BA/VC funding, but not to innovation. Thus, a balanced mix of these human capital resources early on helps in building lasting and successful fintech companies.

Second, we highlight the role of resources provided by a network of supporters. These resources are critical to increasing the chances of survival but play a secondary role in securing BA/VC funding and creating innovation. Third-party endorsements at the time of incorporation are a network resource that increases company survival. Interestingly, fintechs that have access to the resources of a foreign parent are 2.6 times more likely to survive. We provide evidence that, while registered trademarks are themselves relevant to firm survival, they also attract BA/VC funding, which in turn provides helpful financial resources for firm survival. We also find that access to resources from collaboration with a parent company has a strong influence on a fintech. Group structures of startups are an under-researched area, and could be a fruitful avenue for future research.

Third, we provide an overview of the German fintech market, its development, and its disruptive effects. We observe that segments that complement traditional bank services (e.g., alternative payments, IT infrastructure fintech, and search engines) rather than segments that substitute them (e.g., asset management and financing) have higher survival rates, obtain BA/VC financing more often, and have better innovation capacities. Moreover, we observe that tonality in market positioning matters: while fintechs with a pro-social positioning are more likely to fail, this quality correlates significantly with patent applications.

Our work is nevertheless limited to investigating the German fintech market and thus neglects institutional frameworks that interact with business decisions. This limits the external validity of our findings in the context of other countries. Furthermore, due to the lack of high-quality data, we approximate innovation capacity using the number of patents filed rather than their quality or market value. Future research might examine the content of these patents in more detail and determine their market value based on corporate acquisitions. While the present study's higher-resolution picture of startup resources has value *per se*, future studies could focus more on the causal relationships between the different variables. We have laid the foundation for such an analysis, collecting data for all of our variables from the time the fintech was founded such that the later outcome variables cannot have any effect on these explanatory variables. Nevertheless, like most empirical studies, we cannot rule out confounding effects, which might be fruitfully examined in future research.

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FIGURE 1

Kaplan–Meier survival estimates, with 95% confidence intervals.

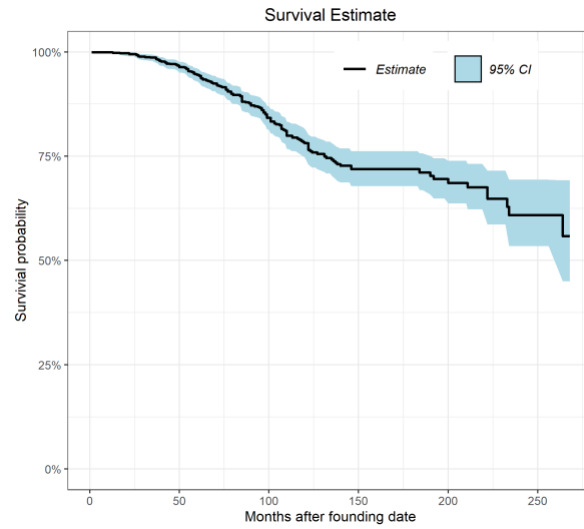


FIGURE 2

Nelson–Aalen estimates of the cumulative hazard rate function to display the time until the first funding by outside BA or VC investor after the founding date in a company register, with 95% confidence intervals.

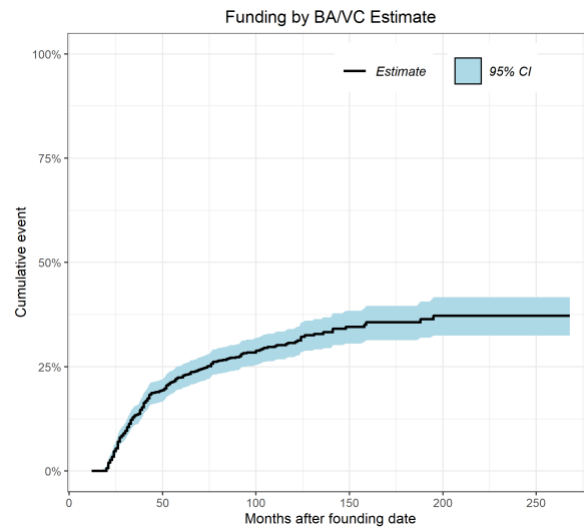


FIGURE 3

Nelson–Aalen estimates of the cumulative hazard rate function to display the time until the first patent filing, with 95% confidence intervals.

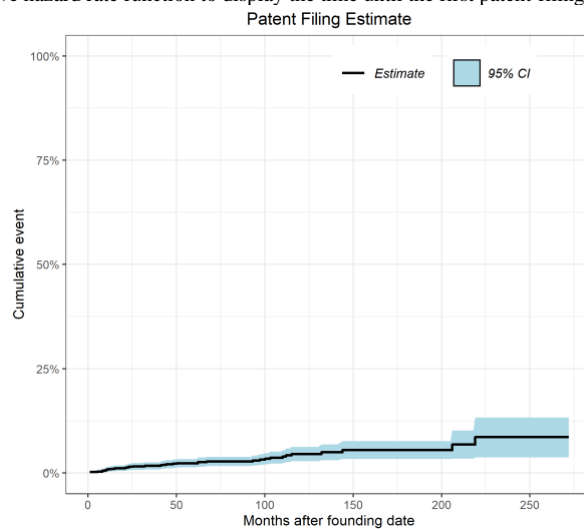


TABLE 1

Descriptive Statistics

This table provides summary statistics on the 892 firms and shows the mean, standard deviation, minimum value, and maximum value for all variables on a monthly scale. The sample covers firms founded from January 1, 2000, to December 31, 2022, obtained from Dorfleitner et al. (2022), and excludes firms without historic websites recorded by archive.org. Variables reported are defined in Appendix Table A1. *Founder social media presence* is the dependent variable in the first step of a Heckman selection model (see Appendix Table A9).

	N	Mean	S.D.	Minimum	Maximum
Dependent					
Firm failure	892	0.183	0.387	0.000	1.000
Funding by BA/VC	892	0.285	0.452	0.000	1.000
Patent filing	892	0.038	0.192	0.000	1.000
Time until firm failure	892	104.956	55.937	1.000	268.000
Time until funding by BA/VC	892	93.689	59.332	12.000	268.000
Time until patent filing	892	104.080	56.214	1.000	268.000
Founder social media presence	892	0.753	0.431	0.000	1.000
Explanatory					
<i>Founder resources</i>					
Number of founders	892	1.811	0.916	1.000	7.000
Business education	892	1.805	2.668	0.000	12.000
STEM education	892	1.483	2.783	0.000	15.000
Alternative education	892	2.084	2.994	0.000	13.000
Entrepreneurial experience	892	2.717	4.320	0.000	32.000
Professional experience	892	3.755	4.218	0.000	13.000
<i>Network resources</i>					
Legal entity among founders	892	0.030	0.171	0.000	1.000
Third-party endorsement	892	0.147	0.354	0.000	1.000
Firm social media presence	892	0.601	0.490	0.000	1.000
Metropolitan area	892	0.516	0.500	0.000	1.000
Bank density	892	0.958	0.662	-1.035	3.913
Fintech density	892	1.788	1.535	-0.895	4.499
<i>Firm resources</i>					
Number of registered trademarks	892	0.041	0.287	0.000	4.000
Number of registered patents	892	0.015	0.120	0.000	1.000
Website size	892	9.102	1.002	1.609	12.328
Foreign branch	892	0.189	0.392	0.000	1.000
Controls					
<i>Founder demographics</i>					
Founder age	892	35.058	8.220	17.000	67.000
Percentage of males	892	91.667	22.896	0.000	100.000
<i>Market segment, targeting and positioning</i>					
Competitive strength	892	6.458	12.777	0.787	100.000
Pro-social tone	892	0.133	0.340	0.000	1.000
Finance tone	892	1.592	1.421	0.026	18.042
Tech tone	892	0.222	0.272	0.002	2.869
B2B	892	0.089	0.284	0.000	1.000
Limited liability	892	0.877	0.329	0.000	1.000
East Germany	892	0.272	0.445	0.000	1.000
Segment		Sub-segments			
Asset management	161	investment and banking, personal financial management, robo-advice, social trading, credit and factoring			
Financing	244	crowdfunding, crowdfunding, crowdlending, donation-based crowdfunding, reward-based crowdfunding, robo-advice, search engines and comparison sites			
Payments	169	alternative payment methods, bigtech, blockchain and cryptocurrencies, other fintechs			
Other fintechs	318	insurance, other fintechs, search engines and comparison sites, technology, it and infrastructure, alternative payment methods			

TABLE 2**Firm Failure**

This table shows results of the regressions on firm failure. Variable definitions are reported in Appendix Table A1. The dependent variable in column (1) measures whether a firm failure occurred and in columns (2)–(5) the duration until firm failure. The method of estimation in column (1) is a probit model (coefficients reported are average marginal effects), in (2) Cox proportional hazards model with fixed effects, in (2)–(4) frailty models with Gaussian- or gamma-distributed random effects (coefficients reported are hazard ratios). Standard errors are robust and clustered at the segment level and are reported in parentheses. Significance levels for coefficients: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

	(1) Probit	Duration			
		(2) Cox	(3) Frailty I	(4) Frailty II	(5) Frailty III
Explanatory					
<i>Founder resources</i>					
Number of founders	-0.0055 (0.015)	0.9652 (0.106)	0.9739 (0.105)	0.9685 (0.106)	0.9677 (0.106)
Business education	0.0052 (0.005)	1.0341 (0.034)	1.034 (0.034)	1.0350 (0.034)	1.0354 (0.034)
STEM education	0.0004 (0.005)	0.9868 (0.034)	0.9851 (0.034)	0.9867 (0.034)	0.9875 (0.034)
Alternative education	-0.0004 (0.004)	0.9926 (0.031)	0.9940 (0.031)	0.9923 (0.031)	0.9927 (0.031)
Entrepreneurial experience	0.0023 (0.003)	1.0189 (0.024)	1.0201 (0.024)	1.0185 (0.024)	1.0181 (0.024)
Professional experience	-0.0075 ** (0.004)	0.9481 *** (0.027)	0.9460 ** (0.027)	0.9491 * (0.027)	0.9501 * (0.027)
<i>Network resources</i>					
Legal entity among founders	0.1032 (0.066)	1.9070 (0.40)	1.8778 (0.401)	1.8624 (0.402)	1.8390 (0.401)
Third-party endorsement	-0.0687 * (0.038)	0.6178 *** (0.283)	0.6138 * (0.283)	0.6142 * (0.283)	0.6154 * (0.283)
Firm social media presence	-0.0312 (0.027)	0.7943 (0.178)	0.7962 (0.177)	0.7938 (0.178)	0.7926 (0.178)
Metropolitan area	0.0478 (0.033)	1.3281 ** (0.232)	1.3200 (0.233)	1.3342 (0.232)	1.3371 (0.232)
Bank density	0.0126 (0.025)	1.0994 (0.176)	1.0885 (0.176)	1.0956 (0.176)	1.0970 (0.176)
Fintech density	0.0033 (0.013)	1.0297 (0.094)	1.0304 (0.094)	1.0302 (0.094)	1.0307 (0.094)
<i>Firm resources</i>					
Number of registered trademarks	-0.0589 (0.050)	0.6713 *** (0.3570)	0.6927 (0.355)	0.6712 (0.357)	0.6726 (0.357)
Number of registered patents	-0.1236 (0.124)	0.4365 (1.027)	0.4046 (1.026)	0.4352 (1.028)	0.4354 (1.028)
Foreign branch	-0.1470 *** (0.038)	0.3415 *** (0.2820)	0.3451 *** (0.28)	0.3394 *** (0.282)	0.3386 *** (0.282)
Website size	-0.0279 ** (0.012)	0.9051 * (0.0640)	0.9022 (0.064)	0.9052 (0.065)	0.9037 (0.065)
Controls					
<i>Founder demographics</i>					
Average founder age	-0.0019 (0.002)	0.9820 * (0.011)	0.9832 (0.011)	0.9825 (0.011)	0.9827 (0.011)
Percentage of males	0.0000 (0.001)	1.0008 (0.003)	1.0005 (0.003)	1.0007 (0.003)	1.0007 (0.003)
<i>Market segment, targeting and positioning</i>					
Competitive strength	-0.0011 (0.002)	0.9857 (0.014)	0.9874 (0.014)	0.9836 (0.014)	0.9816 (0.014)
Pro-social tone	0.1070 *** (0.037)	2.0146 *** (0.240)	2.0133 *** (0.239)	2.0103 *** (0.240)	2.0123 *** (0.240)
Finance tone	-0.0067 (0.009)	0.9516 * (0.058)	0.9567 (0.057)	0.9517 (0.058)	0.9533 (0.058)
Tech tone	-0.0913 * (0.055)	0.5694 *** (0.408)	0.5497 (0.406)	0.5771 (0.409)	0.5758 (0.408)
B2B	-0.0275 (0.046)	0.6651 (0.335)	0.6705 (0.334)	0.6632 (0.335)	0.6615 (0.335)
Limited liability	-0.0596 * (0.036)	0.7702 * (0.230)	0.7520 (0.229)	0.7704 (0.230)	0.7667 (0.230)
Time-fixed effects	FE	FE	FE	RE (Gamma)	RE (Gauss)
Segment effects	FE	FE	RE (Gamma)	RE (Gamma)	RE (Gauss)
Segment = Asset Management	0.0447 (0.037)	1.3270 *** (0.271)			
Segment = Financing	0.0818 ** (0.032)	1.8158 *** (0.215)			
Segment = Payments	0.0488 (0.036)	1.4766 *** (0.252)			
Observations	892	892	892	892	892
Days at risk	2808630	2808630	2808630	2808630	2808630
Events	163	163	163	163	163
Pseudo R-squared	0.1589	0.2542	0.2534	0.2538	0.2518
AIC	801.5068	1845.6206	1843.8498	1847.0155	1846.8345
Log-likelihood	-356.7534	-878.8103	-879.2499	-879.0403	-879.1491

TABLE 3

Funding by BA/VC

This table shows results of the regressions on funding by BA/VC. Variable definitions are reported in Appendix Table A1. The dependent variable in column (1) is whether the firm received funding by BA/VC investor or not, and in columns (2)–(5) the duration until firm received funding by BA/VC investor. The method of estimation in column (1) is a probit model (coefficients reported are average marginal effects), in (2) Cox proportional hazards model with fixed effects, in (2)–(4) frailty models with Gaussian- or gamma-distributed random effects (coefficients reported are hazard ratios). Standard errors are robust and clustered at the segment level and are reported in parentheses. Significance levels for coefficients: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Explanatory	(1) Probit	Duration			
		(2) Cox	(3) Frailty I	(4) Frailty II	(5) Frailty III
Founder resources					
Number of founders	0.0153 (0.016)	1.0941 *** (0.076)	1.0910 (0.076)	1.0955 (0.075)	1.0955 (0.075)
Business education	0.0080 (0.005)	1.0414 ** (0.025)	1.0419 * (0.025)	1.0468 * (0.024)	1.0468 * (0.024)
STEM education	0.0034 (0.005)	1.0123 (0.025)	1.0135 (0.025)	1.0223 (0.024)	1.0223 (0.024)
Alternative education	0.0066 (0.005)	1.0269 (0.022)	1.0261 (0.022)	1.0342 (0.022)	1.0342 (0.022)
Entrepreneurial experience	0.0077 ** (0.004)	1.0330 *** (0.015)	1.0331 ** (0.015)	1.0305 ** (0.015)	1.0305 ** (0.015)
Professional experience	0.0042 (0.004)	1.0248 ** (0.019)	1.0260 (0.018)	1.0369 ** (0.018)	1.0369 ** (0.018)
Network resources					
Legal entity among founders	-0.1423 (0.142)	0.3809 (0.793)	0.3948 (0.786)	0.3743 (0.752)	0.3745 (0.752)
Third-party endorsement	0.0285 (0.039)	1.2090 (0.178)	1.1986 (0.178)	1.1593 (0.175)	1.1593 (0.175)
Firm social media presence	-0.0189 (0.031)	0.8762 * (0.146)	0.8919 (0.145)	0.8553 (0.143)	0.8553 (0.143)
Metropolitan area	0.0140 (0.036)	1.2375 * (0.165)	1.2598 (0.164)	1.2470 (0.164)	1.2470 (0.164)
Bank density	0.0075 (0.029)	1.0598 (0.146)	1.0598 (0.146)	1.0708 (0.146)	1.0708 (0.146)
Fintech density	-0.0275 * (0.015)	0.8749 (0.071)	0.8793 * (0.070)	0.8632 ** (0.071)	0.8632 ** (0.071)
Firm resources					
Number of registered trademarks	0.1653 *** (0.051)	2.0491 *** (0.152)	2.0208 *** (0.151)	1.7969 *** (0.143)	1.7965 *** (0.143)
Number of registered patents	0.0889 (0.109)	1.3572 (0.424)	1.4313 (0.422)	1.3929 (0.411)	1.3935 (0.411)
Foreign branch	0.0401 (0.039)	1.2386 (0.174)	1.2534 (0.173)	1.1925 (0.171)	1.1926 (0.171)
Website size	0.0197 (0.016)	1.1369 (0.085)	1.1369 (0.085)	1.1285 (0.086)	1.1285 (0.086)
Controls					
Founder demographics					
Average founder age	-0.0101 *** (0.002)	0.9534 *** (0.010)	0.9527 *** (0.010)	0.9615 *** (0.010)	0.9615 *** (0.010)
Percentage of males	0.0009 (0.001)	1.0045 ** (0.003)	1.0046 (0.004)	1.0035 (0.003)	1.0035 (0.003)
Market segment, targeting and positioning					
Competitive strength	-0.0011 (0.002)	0.9938 (0.012)	0.9912 (0.012)	0.9635 *** (0.012)	0.9635 *** (0.012)
Pro-social tone	-0.0595 (0.044)	0.8585 (0.207)	0.8553 (0.207)	0.8470 (0.206)	0.8471 (0.206)
Finance tone	-0.0123 (0.012)	0.9768 (0.053)	0.9684 (0.053)	0.9807 (0.052)	0.9807 (0.052)
Tech tone	0.1303 ** (0.052)	1.6274 *** (0.209)	1.6830 ** (0.207)	1.6231 ** (0.205)	1.6232 ** (0.205)
B2B	0.0937 * (0.048)	1.3186 (0.208)	1.3306 (0.207)	1.2308 (0.205)	1.2308 (0.205)
Limited liability	0.2945 *** (0.056)	5.1084 *** (0.365)	5.1800 *** (0.365)	4.9108 *** (0.365)	4.9109 *** (0.365)
Time-fixed effects	FE	FE	FE	RE (Gamma)	RE (Gauss)
Segment effects	FE	FE	RE (Gamma)	RE (Gamma)	RE (Gauss)
<i>Segment = Asset Management</i>	-0.0089 (0.043)	0.8652 *** (0.193)			
<i>Segment = Financing</i>	-0.0648 * (0.037)	0.7045 *** (0.178)			
<i>Segment = Payments</i>	-0.0132 (0.042)	1.0000 (0.187)			
Observations	892	892	892	892	892
Days at risk	2507130	2507130	2507130	2507130	2507130
Events	254	254	254	254	254
Pseudo R-squared	0.1665	0.2176	0.2161	0.1934	0.1917
AIC	976.1969	3143.0403	3140.7169	3138.0124	3138.0121
Log-likelihood	-444.0985	-1527.5201	-1528.3759	-1540.6698	-1540.6726

TABLE 4

Patent filing

This table shows results of the regressions on patent filing. Variable definitions are reported in Appendix Table A1. The dependent variable in column (1) is whether the firm filed a patent or not, and in columns (2)–(5) the duration until firm filed a patent. The method of estimation in column (1) is a probit model (coefficients reported are average marginal effects), in (2) Cox model with fixed effects, in (2)–(4) frailty models with Gaussian- or gamma-distributed random effects (coefficients reported are hazard ratios). Standard errors are robust and clustered at the segment level and are reported in parentheses. Significance levels for coefficients: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Explanatory	Duration				
	(1) Probit	(2) Cox	(3) Frailty I	(4) Frailty II	(5) Frailty III
Founder resources					
Number of founders	0.0096 (0.007)	1.2857 (0.200)	1.2856 (0.200)	1.2252 (0.190)	1.2242 (0.191)
Business education	-0.0018 (0.003)	0.9565 (0.088)	0.9549 (0.086)	0.9420 (0.084)	0.9417 (0.084)
STEM education	0.0037 * (0.002)	1.1229 *** (0.059)	1.1224 ** (0.058)	1.1103 * (0.057)	1.1102 * (0.057)
Alternative education	0.0005 (0.002)	1.0180 (0.067)	1.0188 (0.067)	1.0114 (0.063)	1.0111 (0.063)
Entrepreneurial experience	0.0010 (0.002)	1.0539 * (0.040)	1.0538 (0.040)	1.0557 (0.039)	1.0555 (0.039)
Professional experience	-0.0017 (0.002)	0.9289 (0.061)	0.9328 (0.061)	0.9264 (0.058)	0.9268 (0.058)
Network resources					
Legal entity among founders	-0.0367 (0.041)	0.4208 (1.136)	0.4471 (1.128)	0.4934 (1.092)	0.4968 (1.092)
Third-party endorsement	-0.0022 (0.018)	0.9766 (0.520)	0.9499 (0.516)	1.0025 (0.509)	1.0031 (0.509)
Firm social media presence	-0.0128 (0.014)	0.7019 ** (0.396)	0.6845 (0.396)	0.7075 (0.389)	0.7072 (0.389)
Metropolitan area	-0.0190 (0.017)	0.5942 (0.479)	0.6233 (0.473)	0.6256 (0.445)	0.6279 (0.444)
Bank density	-0.0178 (0.013)	0.6123 (0.366)	0.6122 (0.364)	0.6207 (0.352)	0.6217 (0.351)
Fintech density	-0.0008 (0.006)	0.9573 (0.187)	0.9707 (0.185)	1.0208 (0.176)	1.0207 (0.176)
Firm resources					
Foreign branch	0.0009 (0.017)	1.0517 (0.472)	1.1006 (0.463)	0.9858 (0.461)	0.9847 (0.461)
Website size	-0.0014 (0.007)	0.9465 (0.205)	0.9465 (0.205)	1.0003 (0.201)	1.0018 (0.201)
Controls					
Founder demographics					
Average founder age	0.0011 (0.001)	1.0369 (0.025)	1.0330 (0.025)	1.0314 (0.023)	1.0312 (0.023)
Percentage of males	0.0003 (0.001)	1.0075 (0.011)	1.0082 (0.011)	1.0092 (0.010)	1.0092 (0.010)
Market segment, targeting and positioning					
Competitive strength	0.0001 (0.001)	1.0103 (0.020)	1.0070 (0.020)	0.9952 (0.014)	0.9951 (0.015)
Pro-social tone	0.0382 ** (0.018)	3.0600 *** (0.466)	3.0654 ** (0.462)	2.8038 ** (0.441)	2.7857 ** (0.441)
Finance tone	-0.0068 (0.006)	0.8004 ** (0.166)	0.7893 (0.166)	0.8492 (0.161)	0.8494 (0.161)
Tech tone	-0.0042 (0.025)	0.9553 (0.713)	1.0332 (0.698)	1.0256 (0.681)	1.0324 (0.681)
B2B	0.0158 (0.019)	1.5448 (0.546)	1.5330 (0.544)	1.3688 (0.515)	1.3684 (0.515)
Limited liability	0.0074 (0.021)	1.2074 (0.591)	1.2623 (0.583)	1.1287 (0.571)	1.1346 (0.570)
Time-fixed effects	FE	FE	FE	RE (Gamma)	RE (Gauss)
Segment effects	FE	FE	RE (Gamma)	RE (Gamma)	RE (Gauss)
Segment = Asset Management	-0.0142 (0.021)	0.6768 ** (0.616)			
Segment = Financing	-0.0355 ** (0.015)	0.2513 *** (0.673)			
Segment = Payments	0.0069 (0.022)	1.1901 ** (0.449)			
Observations	892	892	892	892	892
Days at risk	2785170	2785170	2785170	2785170	2785170
Events	34	34	34	34	34
Pseudo R-squared	0.1785	0.132	0.1289	0.088	0.0828
AIC	321.2737	467.4891	460.0661	448.8045	448.7369
Log-likelihood	-118.6368	-191.7446	-192.3074	-199.5779	-199.6199

APPENDIX

TABLE A1

This table reports the definitions of variables and their sources. Website text is obtained from the company homepage as well as 17 subdirectories embedded there, especially those in the navigation bar, accessible around the founding date.

Variable	Description	Source
Dependent		
Firm failure	Dummy variable equal to 1 if firm went into insolvency, was liquidated or dissolved and 0 otherwise.	German and non-German company register, press releases, BvD Amadeus, creditreform
Funding by BA/VC	Dummy variable equal to 1 if firm received funding by an outside BA/VC after the founding date and 0 otherwise.	BvD Amadeus, Crunchbase, German and non-German company register, creditreform, VC websites
Patent filing	Dummy variable equal to 1 if firm or at least one of its founders registered a patent whose description includes fintech industry-related words and 0 otherwise.	PATSTAT
Time until firm failure	Event until firm failure at time t after the founding date.	German and non-German company register, press releases, BvD Amadeus, creditreform
Time until funding by BA/VC	Event until funding by outside BA/VC at time t after the founding date.	BvD Amadeus, Crunchbase, German and non-German company register, creditreform, VC websites
Time until patent filing	Event until patent registration at time t after the founding date.	PATSTAT
Founder social media presence	Dummy variable equal to 1 if at least one firm founder has a LinkedIn/Xing profile and 0 otherwise.	LinkedIn, Xing
Explanatory		
<i>Founder resources</i>		
Number of founders	Total number of founders.	German and non-German company register
Business education	Average years of education of founders at time of founding in business, finance or business-related fields.	LinkedIn, Xing, historical firm websites, internet search
STEM education	Average years of founders' education at time of founding in science, technology, engineering, and mathematics fields.	LinkedIn, Xing, historical firm websites, internet search
Alternative education	Average years of non-business or STEM education of founders at time of founding.	LinkedIn, Xing, historical firm websites, internet search
Entrepreneurial experience	Average years of entrepreneurial experience of founders at time of founding.	LinkedIn, Xing, historical firm websites, internet search
Professional experience	Average years of work experience of founders at time of founding.	LinkedIn, Xing, historical firm websites, internet search
<i>Network resources</i>		
Legal entity among founders	Dummy variable equal to 1 if firm is co-founded by an existing company and 0 otherwise.	German and non-German company register
Third-party endorsement	Dummy variable equal to 1 if firm websites show more than one endorsement around founding date and 0 otherwise.	LinkedIn, Xing, historical firm websites, internet search
Firm social media presence	Dummy variable equal to 1 if firm website links to social media webpages more than three times around founding date and 0 otherwise.	LinkedIn, Xing, historical firm websites, internet search
Metropolitan area	Dummy variable equal to 1 if firm is located in a city with millions of inhabitants and 0 otherwise.	Own calculations
Bank density	Logarithmic average distance of top 50 closest bank to firm's postal address.	Openstreetmap.org, own calculations
Fintech density	Logarithmic average distance of top 50 closest fintechs to firm's postal address.	Openstreetmap.org, own calculations
<i>Firm resources</i>		
Number of registered trademarks	Total number of registered trademarks within the first 12 months of the founding date.	BvD Orbis
Number of registered patents	Total number of registered patents within the first 12 months of the founding date.	PATSTAT
Foreign branch	Dummy variable equal to 1 if firm's main operation is outside of German and 0 otherwise.	Dorflleitner et al. (2022)
Website size	Total word count of firm's website in logarithmic scale.	Historical firm websites via Wayback Machine (archive.org), own calculations
Controls		
<i>Founder demographics</i>		
Average founder age	Average age of founders at startup.	LinkedIn, Xing, historical firm websites, internet search
Percentage of males	Percentage of men among founders.	LinkedIn, Xing, historical firm websites, internet search
<i>Market segment, targeting and positioning</i>		
Competitive strength	The Herfindahl-Hirschman index is 1 divided by the total number of fintechs in the sub-segment at the time the startup was founded.	Dorflleitner et al. (2022), company register, own calculations
Pro-social tone	Dummy variable equal to 1 if firm website uses donation-linked words more than 5 times around founding date and 0 otherwise.	LinkedIn, Xing, historical firm websites, internet search
Finance tone	Percentage share of financial terms in the entire website text around founding date.	Historical firm websites via Wayback Machine (archive.org), own calculations
Tech tone	Percentage share of technical terms in the entire website text around founding date.	Historical firm websites via Wayback Machine (archive.org), own calculations
B2B	Dummy variable equal to 1 if firm website uses business-to-business wording around founding date and 0 otherwise.	LinkedIn, Xing, historical firm websites, internet search
Limited liability	Dummy variable equal to 1 if firm has limited liability legal form and 0 otherwise.	German and non-German company register
Fintech segment	Indicators for four segments: financing, payment, asset management and others.	Dorflleitner et al. (2022)
Founding year	Indicators for years from 2000 to 2022.	German and non-German company register, creditreform, Dorflleitner et al. (2022)
East Germany	Indicator for startup location in eastern Germany.	Company register

TABLE A2

Keywords

This table presents the keywords used to classify texts from webpages and other internet sources. Keywords were used to classify the websites, ignoring upper- and lower-case words and prefix and suffix variations.

Explanatory	Keywords
Founder resources	
Business education	administration, betriebswirt, business administration, business science, bwl, economics, economist, entrepreneurship, finance, financial, finanz, kfm, management science, mba, vkw, volkswirt, vwl, wirtschaftsinfo, wirtschaftsingenieur, wirtschaftswissenschaft
STEM education	biolog, chemie, chemist, computer, computer engineering, engineer, engineering, informatik, information, ingeneur, intelligence, internet, mathematics, mathematik, pyhsics, pyhsik, software, systems, technolog, wirtschaftsinfo, wirtschaftsingenieur
Entrepreneurial experience	accelerator, angle, capitalist, ceo, cofounder, co-founder, early stage, entrepreneur, equity, founder, founding, gruender, gründer, incubator, investor, partner, seed, vc firm, venture, ventures
Network resources	
Third-party endorsement	allied organizations, backed by banks, bank alliances, bankallianzen, branchenkooperationen, collaborative agreements, cooperative ventures, financial institution backing, financial institution partnerships, gemeinsame initiativen, industry collaborations, industry supporters, insurance partnerships, investor network, investorennetzwerk, joint initiatives, kooperationspartner, kooperationsvereinbarungen, kooperative unternehmensprojekte, partnerschaften mit finanzinstituten, strategic alliances, strategic partnerships, strategische allianzen, strategische partnerschaften, supported by insurers, unterstützter der branche, unterstützt von banken, unterstützt von versicherungen, unterstützung von finanzinstituten, verbündete organisationen, versicherungspartnerschaften
Firm social media presence	badoo, bandcamp, bebo, delicious, digg, discord, facebook, flickr, foursquare, friendster, google+, hi5, instagram, itunes, last.fm, linkedin, livejournal, meetup, mixi, myspace, myspace, orkut, periscope, pinterest, playstation network, qzone, reddit, renren, sina weibo, snapchat, soundcloud, spotify, stumbleupon, tagged, telegram, tiktok, tumblr, twitch, twitter, vimeo, vkontakte, wechat, whatsapp, xanga, xbox live, youtube
Metropolitan area	berlin, frankfurt, hong kong, london, munich, cologne, hamburg, new york, san francisco, seattle, shanghai, singapore, sydney, tokyo, toronto, Zurich, paris
Controls	
Firm positioning	
Pro-social tone	altruismus, bedürftig, dankbarkeit, edel, empathie, fairness, freiwilligenarbeit, freiwilligenarbeit, freiwilliger, freundlichkeit, fürsorge, gemeindedienst, gemeinnützig, gemeinnützig, geschenk, gratisgeschenk, großzügigkeit, gute sache, guter wille, gutherzig, humanitär, humanitäres engagement, kostenlose spende, menschlichkeit, mitgeföhl, nicht-geschäftlich, nicht-kommerziell, opfer, philanthropie, philanthropisch, pro bono, selbstlosigkeit, solidarität, sozial, spende, spenden, spenden, spendenaktion, spendenbasiert, spendenbox, spendendose, spendengeist, spendenkampagne, spendenplattform, spendenprogramm, spendenzentrum, spender, teilen, unterprivilegiert, unterstützend, unterstützung, verantwortung, verletzlich, wohlfahrt, wohltäter, wohltätigkeit, wohltätigkeitsarbeit, wohltätigkeitsorganisation, wohltätigkeitsprogramm, wohltätigkeitsveranstaltung, wohlwollen, zurückgeben, zuschuss, aid, altruism, assistance, benefactor, benevolence, caring, charitable, charitable organization, charity, charity event, charity program, charity work, community service, compassion, complimentary, contribution, donate, donating, donation, donation box, donation campaign, donation center, donation drive, donation jar, donation platform, donation program, donation-based, donor, empathy, fairness, free donation, freebie, generosity, gift, giving back, giving spirit, good cause, goodwill, grant, gratitude, hilfe, humanitarian, humanitarianism, humanity, kind-hearted, kindness, needy, noble, non-business, noncommercial, nonprofit, non-profit, non-profit, philanthropic, philanthropy, pro bono, responsibility, sacrifice, selflessness, sharing, social, solidarity, supportive, underprivileged, volunteer, volunteer work, volunteering, vulnerable, welfare
Finance tone	aktie, aktien, altcoin, anleihe, asset, bank, banken, banking, banks, bitcoin, blockchain, bond, borrowing, börse, budget, capital, checkout, collateral, consensus, credit, credit score, crowdfunding, crowdinvesting, crowdlending, crypto market, cryptocurrency, cryptographic, darlehen, decentralized, digital asset, distributed ledger, dividend, dividende, eigenkapital, einnahmen, equity, ersparnisse, etf, etfslaufzeit, ethereum, exchange, factoring, finance, financial, finanzen, finanziert, finanzierung, fonds, forderung, forderungsverkauf, geld, geldanalage, gewinn, gold, hypothek, immutable, insurance, interest, interest rate, investieren, investment, investments, investor, invoice, kredit, lending, liability, loan, loan agreement, merchant, microfinance, mining, money, mortgage, oct, etc, payment, peer-to-peer, portfolio, pos, processor, profit, rechnung, remittance, revenue, savings, settlement, smart contract, steuern, stock, tax, token, trading, transaction, underwriting, verbindlichkeit, vermögenswert, versicherung, vorfinanzierung, wallet, zinsen
Tech tone	ai, algorithm, algorithmus, analytik, api, api integration, api security, api-integration, apis, api-sicherheit, app, artificial intelligence, augmented reality, automated trading, automation, automatisierter handel, automatisierung, betrugserkennung, big data, biometric authentication, biometrics, biometrie, biometrische authentifizierung, blockchain, chatbot, cloud computing, cloud security, cloud-sicherheit, crowdfunding, crypto, cryptocurrency, cyber, cyber defense, cyber insurance, cyber resilience, cyber threats, cyberabwehr, cyberbedrohungen, cyber-resilienz, cybersecurity, cybersicherheit, cyber-versicherung, data, data analytics, data privacy, data science, data visualization, data warehousing, daten, datenanalyse, datenarchivierung, datenschutz, datenvisualisierung, datenwissenschaft, digital, digital banking, digital identity, digital transformation, digital wallet, digitale brieftasche, digitale identität, digitale transformation, digitales banking, e-commerce, erweiterte realität, fintech, fintech api, fintech-api, fraud detection, innovation, insurtech, internet der dinge, internet of things, internet security, internet-sicherheit, it, it consulting, it-beratung, ki, krypto, kryptowährung, künstliche intelligenz, machine learning, maschinelles lernen, ml, mobil, mobile, mobile app, mobile payments, mobile zahlungen, network infrastructure, network security, netzwerkinfrastruktur, netzwerksicherheit, open banking, p2p, payment, payment gateway, peer, peer-to-peer, platform, platform, predictive analytics, quantitative analyse, quantitative analysis, regtech, risikomanagement, risk management, robotic process automation, scalable, secure, security, sicher, sicherheit, skalierbar, smart contracts, software development, softwareentwicklung, technological, technologie, technologisch, technology, token, virtual reality, virtuelle realität, vorhersagende analyse, wallet, zahlung, zahlungs-gateway
B2B	enterprise solutions, b2b, b-2-b, b2b commerce, b2b payments, b2b-commerce, b2b-zahlungen, b2c2b, beschaffungslösungen, business process outsourcing, business-to-business, commercial clients, corporate clients, geschäftsprozessauslagerung, gewerbliche kunden, großhandel, großhandelsdienstleistungen, großhandelsvertrieb, lieferantenmanagement, lieferkettenmanagement, procurement solutions, professional services, professionelle dienstleistungen, supply chain management, unternehmenskunden, unternehmenslösungen, vendor management, wholesale, wholesale distribution, wholesale services
Limited liability	(haftungsbeschränkt), AG, ApS, B.V., Corp., GmbH & Co. KG, Ltd., mbH, N.V., Oy, P.L.C., PLC, S.C.A., SA, SARL, SAS, SE, UG (haftungsbeschränkt) & Co. KG

TABLE A3

Correlation matrix

This table shows results of the Pearson correlation matrix. Significance levels for coefficients: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1 Firm failure	1.00***														
2 Funding by BA/VC	-0.18***	1.00***													
3 Patent filing	0.01	0.03	1.00***												
4 Time until firm failure	-0.14***	-0.01	0.08**	1.00***											
5 Time until funding by BA/VC	0.11***	-0.47***	0.05	0.78***	1.00***										
6 Time until patent filing	0.04	-0.06*	-0.15***	0.85***	0.76***	1.00***									
7 Founder social media presence	-0.09**	0.25***	0.02	-0.17***	-0.29***	-0.17***	1.00***								
8 Number of founders	-0.03	0.12***	0.03	-0.07**	-0.13***	-0.11***	0.19***	1.00***							
9 Business education	-0.01	0.14***	-0.04	-0.21***	-0.25***	-0.20***	0.39***	0.18***	1.00***						
10 STEM education	-0.04	0.10***	0.07**	-0.13***	-0.17***	-0.15***	0.31***	0.35***	0.06*	1.00***					
11 Alternative education	-0.02	0.13***	0.01	-0.13***	-0.18***	-0.13***	0.40***	0.23***	0.10***	0.10***	1.00***				
12 Entrepreneurial experience	-0.06*	0.12***	0.03	-0.11***	-0.17***	-0.13***	0.36***	0.10***	0.19***	0.12***	0.26***	1.00***			
13 Professional experience	-0.11***	0.11***	-0.04	-0.29***	-0.31***	-0.29***	0.51***	0.14***	0.34***	0.19***	0.26***	0.42***	1.00***		
14 Legal entity among founders	0.07**	-0.08**	-0.00	0.20***	0.23***	0.16***	-0.28***	-0.00	-0.12***	-0.07**	-0.11***	-0.11***	-0.12***	1.00***	
15 Third-party endorsement	-0.07**	0.05	0.00	0.10***	0.04	0.08**	0.08**	0.01	0.06*	-0.05	-0.01	0.00	0.03	-0.02	1.00***
16 Firm social media presence	-0.04	0.03	-0.01	0.04	0.01	0.05	0.13***	0.01	0.05	0.08**	0.07**	0.14***	0.11***	-0.00	0.06*
17 Metropolitan area	0.04	0.12***	-0.02	-0.13***	-0.18***	-0.13***	0.18***	0.13***	0.16***	0.10***	0.10***	0.04	-0.08**	-0.02	0.06*
18 Bank density	0.05	-0.11***	-0.04	0.06*	0.12***	0.08**	-0.15***	-0.08**	-0.13***	-0.08**	-0.06*	-0.08**	-0.04	0.06*	-0.07**
19 Fintech density	0.01	-0.15***	0.01	0.11***	0.18***	0.13***	-0.16***	-0.11***	-0.15***	-0.06*	-0.12***	-0.08**	-0.04	0.08**	-0.03
20 Number of registered trademarks	-0.02	0.14***	0.15***	0.03	-0.08**	-0.01	0.02	0.08**	0.01	0.04	0.06*	-0.01	-0.01	0.07**	0.03
21 Number of registered patents	-0.03	0.07**	0.61***	-0.01	-0.04	-0.14***	0.07**	0.04	0.01	0.08**	0.04	0.09***	0.00	-0.02	-0.02
22 Foreign branch	-0.10***	0.02	0.04	0.12***	0.01	0.10***	0.05	0.02	-0.06	0.12***	0.04	0.12***	0.01	-0.02	-0.06
23 Website size	-0.08**	0.07**	0.01	0.08**	0.03	0.04	0.17***	0.07**	0.08**	0.08**	0.06*	0.05	0.08**	-0.01	0.14***
24 Average founder age	-0.04	-0.13***	0.01	-0.14***	-0.07**	-0.16***	-0.23***	-0.10***	-0.01	-0.07**	0.02	0.18***	0.18***	0.15***	0.01
25 Percentage of males	-0.02	0.07**	0.03	0.03	-0.02	0.01	0.11***	-0.01	0.02	0.04	-0.02	-0.01	0.03	-0.00	0.08**
26 Pro-social tone	0.05	-0.01	0.08**	0.03	0.02	0.01	0.09***	-0.02	-0.04	0.08**	0.10***	0.06*	0.02	0.01	-0.03
27 Competitive strength	-0.04	-0.09***	0.02	0.59***	0.58***	0.54***	-0.19***	-0.01	-0.13***	-0.12***	-0.13***	-0.08**	-0.18***	0.15***	0.08**
28 Finance tone	-0.03	-0.01	-0.02	0.02	-0.01	0.01	0.01	-0.00	-0.05	0.08**	0.01	0.01	-0.01	0.06	-0.06*
29 Tech tone	-0.06*	0.07**	0.01	-0.08**	-0.11***	-0.09***	0.06*	-0.02	0.00	0.11***	0.02	0.09***	0.06	-0.06*	-0.10***
30 B2B	-0.04	0.08**	0.04	0.12***	0.04	0.07**	0.07**	0.02	0.03	0.05	-0.01	0.02	0.03	0.01	0.08**
31 Limited liability	-0.07**	0.18***	0.00	0.01	-0.07**	0.01	0.09**	0.01	0.13***	-0.02	0.03	0.07**	0.05	-0.03	0.08**
32 East Germany	0.06*	0.11***	-0.06*	-0.12	-0.12***	-0.11***	0.12***	0.06	0.08*	0.07**	0.11***	0.14***	0.11***	0.01	0.00

Variable	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
1 Firm failure																
2 Funding by BA/VC																
3 Patent filing																
4 Time until firm failure																
5 Time until funding by BA/VC																
6 Time until patent filing																
7 Founder social media presence																
8 Number of founders																
9 Business education																
10 STEM education																
11 Alternative education																
12 Entrepreneurial experience																
13 Professional experience																
14 Legal entity among founders																
15 Third-party endorsement																
16 Firm social media presence	1.00***															
17 Metropolitan area	0.06*	1.00***														
18 Bank density	0.01	-0.38***	1.00***													
19 Fintech density	0.00	-0.63***	0.65***	1.00***												
20 Number of registered trademarks	0.05	0.02	-0.02	-0.01	1.00***											
21 Number of registered patents	-0.04	0.06*	-0.05	-0.05	0.11***	1.00***										
22 Foreign branch	0.08**	-0.05	0.00	0.11***	0.05	0.04	1.00***									
23 Website size	0.31***	0.05	-0.00	-0.05	0.02	0.01	-0.02	1.00***								
24 Average founder age	-0.06*	-0.07**	0.07**	0.08**	0.01	0.05	-0.05	-0.07**	1.00***							
25 Percentage of males	-0.04	0.04	-0.05	-0.02	0.03	0.00	0.03	-0.03	-0.00	1.00***						
26 Pro-social tone	0.17***	0.08**	-0.03	-0.02	0.04	0.04	0.24***	0.19***	-0.07**	-0.08**	1.00***					
27 Competitive strength	-0.06*	-0.06*	0.03	0.06*	-0.03	-0.04	-0.02	0.04	-0.07**	-0.01	0.00	1.00***				
28 Finance tone	-0.08**	0.03	-0.09***	-0.09***	0.03	-0.01	0.22***	-0.07**	-0.03	-0.00	0.14***	0.03	1.00***			
29 Tech tone	-0.10***	0.06*	-0.08**	-0.09***	-0.04	0.04	0.04	-0.13***	0.05	0.04	0.04	-0.05	0.17***	1.00***		
30 B2B	0.02	0.02	-0.04	-0.07**	0.09***	-0.00	0.04	0.14***	-0.03	-0.01	0.14***	0.04	0.10***	0.02	1.00***	
31 Limited liability	-0.03	0.02	-0.07**	-0.03	0.04	0.05	-0.14***	-0.02	0.07**	0.06*	-0.10***	0.03	-0.04	-0.01	-0.01	1.00***
32 East Germany	0.07**	0.36	-0.03	-0.31**	0.01	-0.03	-0.19***	0.08**	-0.10***	-0.02	-0.02	-0.08**	-0.03	-0.04	-0.02	-0.02

TABLE A4

West/East Germany

This table shows results of the regressions on firm failure, funding by BA/VC, and patent filing using an additional variable *East Germany* to indicate whether a fintech is founded in East Germany between January 1, 2000, and December 31, 2021. Variable definitions are reported in Appendix Table A1. The dependent variables in column (1)–(2) is the duration of firm failure, in columns (3)–(4) is the duration of firm received funding by BA/VC, and (5)–(6) is the duration of patent filing. Columns (2), (4), and (6) exclude Berlin. Controls incorporates all variables that are also used in the regressions in Table 2, 3, and 4. The method of estimation are frailty models with gamma-distributed random effects, respectively (coefficients reported are hazard ratios). Standard errors are robust and clustered at the segment level and are reported in parentheses. Significance levels for coefficients: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

	Duration					
	Survival		Funding by BA/VC		Patent	
	(1) All	(2) Ex Berlin	(3) All	(4) Ex Berlin	(5) All	(6) Ex Berlin
East Germany	1.0408 (0.2003)	1.1676 (0.376)	1.328* (0.1613)	1.9903** (0.3332)	0.5971 (0.5472)	0.4873 (1.1222)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Segment	FE	FE	FE	FE	FE	FE
Year	FE	FE	FE	FE	FE	FE
Observations	892	691	892	691	892	691
Days at risk	2785170	2785170	2785170	2785170	2785170	2785170
Events	163	148	254	228	34	30
Pseudo R-squared	0.2518	0.2724	0.1938	0.1924	0.0855	0.1244
AIC	1848.8001	1280.9958	3137.0391	2102.9802	449.7531	385.2584
Log-likelihood	-879.1372	-595.3075	-1539.5221	-1020.8401	-199.1345	-162.4596

TABLE A5

Alternative survival models

This table shows the results of the regressions on firm failure, funding by BA/VC, and patent filing. Variable definitions are reported in Appendix Table A1. The dependent variables in columns (1)–(4) are firm failure duration, in columns (5)–(8) is firm received funding by BA/VC duration, and (9)–(12) is patent filing duration. The estimation method in columns is Cox, as in Tables 2, 3, and 4, and more the survival models with different distribution functions (Gaussian, Weibull, and exponential). The coefficients reported are hazard ratios. Bold numbers indicate additional significance compared to the Frailty III model in Tables 2, 3, and 4. Standard errors are robust, clustered at the segment level, and reported in parentheses. Significance levels for coefficients: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

	Firm failure				Funding by BA/VC				Patent filing			
	(1) Cox	(2) Gaussian	(3) Weibull	(4) Exponential	(5) Cox	(6) Gaussian	(7) Weibull	(8) Exponential	(9) Cox	(10) Gaussian	(11) Weibull	(12) Exponential
Explanatory												
<i>Founder resources</i>												
Number of founders	0.9652 (0.106)	1.0163 (0.017)	1.0093 (0.017)	1.0316 (0.051)	1.0941 *** (0.076)	0.9313 *** (0.003)	0.9415 *** (0.008)	0.9213 *** (0.008)	1.2857 (0.2)	0.6942 (0.377)	0.7317 (0.358)	0.7785 (0.264)
Business education	1.0341 (0.034)	0.9885 (0.009)	0.9901 (0.007)	0.97 (0.02)	1.0414 ** (0.025)	0.9658 *** (0.011)	0.9739 ** (0.012)	0.9648 ** (0.014)	0.9565 (0.088)	1.0709 (0.063)	1.057 (0.064)	1.0464 (0.056)
STEM education	0.9868 (0.034)	1.0001 (0.01)	1.0038 (0.01)	1.0087 (0.027)	1.0123 (0.025)	0.9921 (0.01)	0.9904 (0.009)	0.986 (0.011)	1.1229 *** (0.059)	0.8679 *** (0.055)	0.864 *** (0.055)	0.8858 *** (0.038)
Alternative education	0.9926 (0.031)	1.0023 (0.007)	1.0022 (0.007)	1.0033 (0.024)	1.0269 (0.022)	0.9815 (0.015)	0.9821 (0.013)	0.9755 (0.017)	1.018 (0.067)	0.9773 (0.056)	0.9788 (0.061)	0.9835 (0.052)
Entrepreneur experience	1.0189 (0.024)	0.9932 (0.005)	0.9948 (0.004)	0.9866 (0.011)	1.033 *** (0.015)	0.9781 *** (0.007)	0.9781 *** (0.006)	0.9695 *** (0.008)	1.0539 * (0.04)	0.9409 (0.044)	0.9324 (0.05)	0.9408 (0.04)
Professional experience	0.9481 *** (0.027)	1.0183 *** (0.004)	1.016 *** (0.005)	1.049 *** (0.008)	1.0248 ** (0.019)	0.9825 ** (0.007)	0.9832 ** (0.007)	0.9759 ** (0.011)	0.9289 (0.061)	1.0882 (0.089)	1.0995 (0.088)	1.0831 (0.075)
<i>Network resources</i>												
Legal entity among founders	1.907 (0.403)	0.8246 (0.143)	0.8137 (0.127)	0.5454 * (0.343)	0.3809 (0.793)	2.1723 (0.537)	1.7687 (0.549)	2.3554 (0.717)	0.4208 (1.136)	3.0363 (1.425)	2.9986 (1.436)	2.3792 (1.197)
Third-party endorsement	0.6178 *** (0.283)	1.1883 *** (0.034)	1.1591 *** (0.034)	1.5533 *** (0.085)	1.209 (0.178)	0.8991 (0.105)	0.8657 (0.093)	0.8459 (0.13)	0.9766 (0.52)	1.0614 (0.603)	1.0367 (0.605)	1.0329 (0.491)
Firm social media presence	0.7943 (0.178)	1.076 (0.061)	1.0738 (0.061)	1.2219 (0.177)	0.8762 * (0.146)	1.07 (0.051)	1.0937 * (0.05)	1.1199 * (0.064)	0.7019 ** (0.396)	1.5285 ** (0.199)	1.5701 ** (0.221)	1.4583 ** (0.162)
Metropolitan region	1.3281 ** (0.232)	0.9152 (0.059)	0.9193 (0.052)	0.774 *** (0.099)	1.2375 * (0.165)	0.8626 ** (0.087)	0.8669 * (0.077)	0.841 (0.115)	0.5942 (0.479)	1.8661 (0.742)	1.8956 (0.774)	1.6853 (0.706)
Bank density	1.0994 (0.176)	0.9792 (0.064)	0.9705 (0.063)	0.9335 (0.167)	1.0598 (0.146)	0.9756 (0.129)	0.9607 (0.108)	0.958 (0.152)	0.6123 (0.366)	1.825 (0.437)	1.8531 (0.387)	1.6464 (0.356)
Fintech density	1.0297 (0.094)	0.9925 (0.021)	0.9926 (0.023)	0.9785 (0.055)	0.8749 (0.071)	1.0868 (0.069)	1.1016 (0.067)	1.1376 (0.093)	0.9573 (0.187)	1.0696 (0.182)	1.0479 (0.184)	1.0392 (0.148)
<i>Firm resources</i>												
Number of registered trademarks	0.6713 *** (0.357)	1.1237 *** (0.039)	1.1228 *** (0.039)	1.425 *** (0.115)	2.0491 *** (0.152)	0.5522 *** (0.103)	0.5935 *** (0.181)	0.5109 *** (0.226)				
Number of registered patents	0.4365 (1.027)	1.3381 (0.342)	1.3046 (0.331)	2.3391 (0.95)	1.3572 (0.7904 **)	0.7722 (0.197)	0.7722 (0.161)	0.7259 * (0.189)				
Foreign branch	0.3415 *** (0.282)	1.4382 *** (0.099)	1.3825 *** (0.098)	2.6212 *** (0.285)	1.2386 (0.174)	0.8558 (0.189)	0.8074 (0.171)	0.8074 (0.229)	1.0517 (0.472)	0.9659 (0.282)	0.9458 (0.35)	0.964 (0.299)
Website size	0.9051 * (0.064)	1.0522 * (0.027)	1.0325 * (0.018)	1.1171 *** (0.038)	1.1369 (0.085)	0.9151 (0.081)	0.917 (0.071)	0.8875 (0.1)	0.9465 (0.205)	1.0688 (0.064)	1.0726 (0.056)	1.0579 (0.039)
Controls												
<i>Founder demographics</i>												
Average founder age	0.982 * (0.011)	1.0045 (0.004)	1.005 (0.003)	1.0137 (0.009)	0.9534 *** (0.01)	1.034 *** (0.006)	1.0346 *** (0.006)	1.0481 *** (0.01)	1.0369 (0.025)	0.9543 (0.047)	0.9551 (0.044)	0.9635 (0.032)
Percentage of males	1.0008 (0.003)	0.9994 (0.001)	0.9997 (0.001)	0.9994 (0.003)	1.0045 ** (0.003)	0.997 (0.002)	0.9967 ** (0.002)	0.9955 ** (0.002)	1.0075 (0.011)	0.9913 (0.006)	0.9905 (0.007)	0.9922 (0.006)
<i>Market segment, targeting and positioning</i>												
Competitive strength	0.9857 (0.014)	1.0039 (0.003)	1.0043 (0.003)	1.0118 (0.01)	0.9938 (0.012)	1.004 (0.007)	1.0053 (0.008)	1.0077 (0.011)	1.0103 (0.02)	0.9909 * (0.005)	0.99 (0.009)	0.9917 (0.007)
Pro-social tone	2.0146 *** (0.24)	0.7992 *** (0.086)	0.8086 ** (0.087)	0.5233 *** (0.209)	0.8585 (0.207)	1.1841 (0.115)	1.1072 (0.125)	1.1779 (0.18)	3.06 *** (0.466)	0.2537 *** (0.245)	0.2452 *** (0.316)	0.3188 *** (0.408)
Finance tone	0.9516 * (0.058)	1.0216 *** (0.007)	1.0157 ** (0.006)	1.0422 (0.027)	0.9768 (0.053)	1.0237 (0.02)	1.0227 (0.026)	1.0349 (0.033)	0.8004 ** (0.166)	1.3013 (0.166)	1.3301 * (0.146)	1.2653 ** (0.096)
Tech tone	0.5694 *** (0.408)	1.2165 *** (0.052)	1.1821 *** (0.061)	1.727 *** (0.15)	1.6274 *** (0.209)	0.697 ** (0.179)	0.7191 ** (0.132)	0.6277 *** (0.167)	0.9553 (0.713)	1.0651 (0.645)	1.0388 (0.634)	1.0179 (0.501)
B2B	0.6651 (0.335)	1.1441 (0.087)	1.1197 (0.076)	1.3244 (0.233)	1.3186 (0.208)	0.752 * (0.166)	0.8357 (0.154)	0.7558 (0.188)	1.5448 (0.546)	0.5591 (0.376)	0.5833 (0.355)	0.6409 (0.283)
Limited liability	0.7702 * (0.23)	1.1069 * (0.055)	1.0917 (0.056)	1.335 ** (0.137)	5.1084 *** (0.365)	0.3286 *** (0.132)	0.3186 *** (0.13)	0.1992 *** (0.171)	1.2074 (0.591)	0.8402 (0.865)	0.8042 (0.86)	0.8396 (0.687)
Time-fixed effects	FE	FE	FE	FE	FE	FE	FE	FE	FE	FE	FE	FE
Segment-fixed effects	FE	FE	FE	FE	FE	FE	FE	FE	FE	FE	FE	FE
<i>Segment = Asset</i>												
Management	1.327 *** (0.271)	0.9072 *** (0.015)	0.9223 *** (0.018)	0.7794 *** (0.065)	0.8652 *** (0.193)	1.1767 *** (0.04)	1.0736 ** (0.03)	1.1032 ** (0.038)	0.6768 ** (0.616)	1.7362 ** (0.216)	1.6022 * (0.263)	1.4594 ** (0.17)
Segment = Financing	1.8158 *** (0.215)	0.8358 *** (0.018)	0.8383 *** (0.01)	0.5947 *** (0.04)	0.7045 *** (0.178)	1.3533 *** (0.029)	1.2553 *** (0.04)	1.3746 *** (0.054)	0.2513 *** (0.673)	5.8526 *** (0.26)	5.5458 *** (0.273)	3.9948 *** (0.125)
Segment = Payments	1.4766 *** (0.252)	0.8917 *** (0.023)	0.8918 *** (0.028)	0.7239 *** (0.084)	1 (0.187)	1.0517 ** (0.02)	0.985 (0.057)	1.0045 (0.059)	1.1901 ** (0.449)	0.8778 (0.273)	0.8141 (0.155)	0.8433 * (0.091)
Observations	892	892	892	892	892	892	892	892	892	892	892	892
Days at Risk	2808630	2808630	2808630	2808630	2507130	2507130	2507130	2507130	2785170	2785170	2785170	2785170
Events	163	163	163	163	254	254	254	254	34	34	34	34
Pseudo R-squared	0.2542	0.2529	0.2669	0.1478	0.2176	0.2778	0.2783	0.246	0.132	0.1022	0.1035	0.104
AIC	1845.6206	2192.5856	2184.6192	2355.0155	3143.0403	3237.4155	3260.5824	3296.6512	467.4891	645.8851	645.23	645.0607
Log-likelihood	-878.8103	-1050.2928	-1046.3096	-1132.5077	-1527.5201	-1572.7077	-1584.2912	-1603.3256	-191.7446	-278.9425	-278.615	-279.5304

TABLE A6

Subsample regressions

This table shows results of the regressions on firm failure, funding by BA/VC, and patent filing using a subsample of firms founded between January 1, 2008, and December 31, 2021. Variable definitions are reported in Appendix Table A1. The dependent variables in column (1)–(2) are whether a firm failure occurred and its duration, respectively, in columns (3)–(4) is whether a firm received funding by BA/VC and its duration, respectively, and (5)–(6) is patent filing, occurrence, respectively duration. The method of estimation in columns (1), (3), and (5) are probit models (coefficients reported are average marginal effects) and in columns (2), (4), and (6) frailty models with gamma-distributed random effects, respectively (coefficients reported are hazard ratios). Standard errors are robust and clustered at the segment level and are reported in parentheses. Significance levels for coefficients: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Explanatory	Firm failure		Funding by BA/VC		Patent filing	
	(1) Probit	(2) Frailty II	(3) Probit	(4) Frailty II	(5) Probit	(6) Frailty II
Founder resources						
Number of founders	-0.0037 (0.016)	0.9891 (0.113)	0.0110 (0.018)	1.0608 (0.079)	0.0122 * (0.007)	1.5124 * (0.222)
Business education	0.0037 (0.005)	1.0298 (0.036)	0.0072 (0.006)	1.0410 (0.025)	-0.0021 (0.003)	0.9136 (0.099)
STEM education	-0.0005 (0.005)	0.9832 (0.036)	0.0040 (0.006)	1.0200 (0.025)	0.0033 (0.002)	1.1170 * (0.064)
Alternative education	-0.0019 (0.005)	0.9786 (0.032)	0.0055 (0.005)	1.0281 (0.023)	-0.0001 (0.002)	0.9995 (0.075)
Entrepreneurial experience	0.0033 (0.004)	1.0254 (0.024)	0.0067 * (0.004)	1.0267 * (0.015)	0.0001 (0.001)	1.0370 (0.045)
Professional experience	-0.0064 * (0.004)	0.9526 * (0.028)	0.0045 (0.004)	1.0344 * (0.018)	-0.0006 (0.002)	0.9464 (0.066)
Network resources						
Legal entity among founders	0.1086 (0.096)	2.221 (0.543)	-0.0484 (0.174)	0.6319 (0.789)	-0.2723 (36.444)	0.0010 (0.001)
Third-party endorsement	-0.1318 *** (0.046)	0.3933 *** (0.359)	0.0066 (0.045)	1.1367 (0.193)	-0.0156 (0.021)	0.6087 (0.775)
Firm social media presence	-0.0438 (0.028)	0.7466 (0.189)	-0.0071 (0.034)	0.8702 (0.151)	-0.0140 (0.014)	0.8374 (0.472)
Metropolitan area	0.0443 (0.035)	1.2922 (0.243)	0.0219 (0.040)	1.2911 (0.174)	-0.0184 (0.016)	0.5629 (0.511)
Bank density	0.0277 (0.026)	1.1984 (0.187)	-0.0118 (0.032)	0.9604 (0.154)	-0.0127 (0.013)	0.6324 (0.440)
Fintech density	-0.0033 (0.014)	0.9853 (0.099)	-0.0223 (0.016)	0.8965 (0.074)	-0.0094 (0.006)	0.7480 (0.205)
Firm resources						
Number of registered trademarks	-0.0786 (0.053)	0.5622 (0.402)	0.1747 *** (0.055)	1.7557 *** (0.144)		
Number of registered patents	-0.0994 (0.125)	0.4818 (1.035)	0.1098 (0.118)	1.4499 (0.414)		
Foreign branch	-0.1344 *** (0.039)	0.3765 *** (0.283)	0.0139 (0.043)	1.1107 (0.184)	0.0117 (0.016)	1.2494 (0.510)
Website size	-0.0238 * (0.013)	0.9266 (0.068)	0.0298 * (0.018)	1.1978 ** (0.092)	-0.0011 (0.006)	0.9489 (0.226)
Controls						
Founder demographics						
Average founder age	-0.0031 * (0.002)	0.9769 * (0.012)	-0.0098 *** (0.002)	0.9608 *** (0.010)	0.0016 * (0.001)	1.0493 (0.030)
Percentage of males	0.0002 (0.001)	1.0014 (0.003)	0.0005 (0.001)	1.0011 (0.003)	0.0001 (0.001)	1.0005 (0.011)
Market segment, targeting and positioning						
Competitive strength	-0.0129 * (0.007)	0.8749 ** (0.054)	0.0016 (0.006)	0.9484 ** (0.027)	-0.0002 (0.002)	0.9871 (0.077)
Pro-social tone	0.1020 *** (0.039)	1.9730 *** (0.249)	-0.0635 (0.049)	0.7920 (0.214)	0.0369 ** (0.017)	3.5894 ** (0.519)
Finance tone	-0.0097 (0.009)	0.9273 (0.062)	-0.0109 (0.013)	1.0018 (0.053)	-0.0022 (0.005)	0.9403 (0.171)
Tech tone	-0.0993 * (0.058)	0.5640 (0.428)	0.1417 ** (0.056)	1.6525 ** (0.211)	-0.0104 (0.025)	0.7963 (0.823)
B2B	-0.0101 (0.051)	0.7679 (0.366)	0.1116 ** (0.054)	1.2508 (0.218)	0.0321 * (0.018)	2.7517 * (0.550)
Limited liability	-0.0628 * (0.037)	0.7571 (0.236)	0.2847 *** (0.059)	4.4302 *** (0.366)	0.0009 (0.019)	0.9645 (0.606)
Time effects	FE	RE (Gamma)	FE	RE (Gamma)	FE	RE (Gamma)
Segment effects	FE	RE (Gamma)	FE	RE (Gamma)	FE	RE (Gamma)
Segment = Asset Management	0.1036 ** (0.044)		0.0036 (0.048)		-0.0372 ** (0.018)	
Segment = Financing	0.1249 *** (0.035)		-0.0716 * (0.040)		-0.0387 ** (0.016)	
Segment = Payments	0.0727 * (0.038)		-0.0127 (0.048)		0.0003 (0.024)	
Observations	776	776	776	776	776	776
Days at risk	2069610	2069610	1820850	1820850	2082840	2082840
Events	146	146	231	231	25	25
Pseudo R-squared	0.150761	0.2319	0.150761	0.1726	0.150761	0.17
AIC	692.9726	1635.6788	882.4446	2823.7032	245.1387	413.1351
Log-likelihood	-306.4863	-778.4595	-401.2223	-1384.9078	-84.5694	-138.4666

TABLE A7

Sub-segment regressions

This table shows results of the regressions on firm failure, funding by BA/VC, and patent filing using a subsample of firms founded between January 1, 2000, and December 31, 2021. Variable definitions are reported in Appendix Table A1. The dependent variable in column (1)–(2) are whether a firm failure occurred and its duration, respectively, in columns (3)–(4) is whether a firm received funding by BA/VC and its duration, respectively, and (5)–(6) is patent filing, occurrence, respectively duration. The method of estimation in columns (1), (3), and (5) are probit models (coefficients reported are average marginal effects) and in columns (2), (4), and (6) frailty models with gamma-distributed random effects, respectively (coefficients reported are hazard ratios). Standard errors are robust and clustered at the segment level and are reported in parentheses. Significance levels for coefficients: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

	Firm failure		Funding by BA/VC		Patent filing	
	(1) Probit	(2) Frailty I	(3) Probit	(4) Frailty I	(5) Probit	(6) Frailty I
Explanatory						
<i>Founder resources</i>						
Number of founders	-0.0047 (0.015)	0.9760 (0.105)	0.0134 (0.016)	1.0861 (0.075)	0.0084 (0.007)	1.2883 (0.200)
Business education	0.0041 (0.005)	1.0338 (0.035)	0.0115 ** (0.005)	1.0516 ** (0.025)	-0.0006 (0.003)	0.9507 (0.085)
STEM education	0.0012 (0.005)	0.9900 (0.035)	0.0040 (0.005)	1.0132 (0.025)	0.0040 * (0.002)	1.1210 ** (0.057)
Alternative education	-0.0017 (0.004)	0.9928 (0.031)	0.0072 (0.005)	1.0275 (0.022)	0.0006 (0.002)	1.0192 (0.067)
Entrepreneurial experience	0.0014 (0.004)	1.0179 (0.024)	0.0070 ** (0.004)	1.0322 ** (0.015)	0.0009 (0.002)	1.0536 (0.039)
Professional experience	-0.0063 * (0.004)	0.9492 * (0.027)	0.0020 (0.004)	1.0185 (0.019)	-0.0018 (0.002)	0.9396 (0.060)
<i>Network resources</i>						
Legal entity among founders	0.0916 (0.066)	1.8023 (0.404)	-0.1233 (0.144)	0.3722 (0.809)	-0.0346 (0.040)	0.4865 (1.116)
Third-party endorsement	-0.0809 ** (0.038)	0.5756 * (0.284)	0.0284 (0.039)	1.2333 (0.179)	-0.0094 (0.019)	0.9180 (0.512)
Firm social media presence	-0.0385 (0.027)	0.7646 (0.178)	-0.0061 (0.031)	0.9247 (0.146)	-0.0161 (0.014)	0.6581 (0.397)
Metropolitan area	0.0407 (0.033)	1.2572 (0.231)	0.0164 (0.036)	1.257 (0.165)	-0.0169 (0.017)	0.6756 (0.464)
Bank density	0.0038 (0.025)	1.0457 (0.175)	0.0027 (0.028)	1.0412 (0.147)	-0.0188 (0.013)	0.6123 (0.362)
Fintech density	0.0056 (0.013)	1.0411 (0.094)	-0.0229 (0.014)	0.8878 * (0.071)	0.0009 (0.006)	0.9937 (0.181)
<i>Firm resources</i>						
Number of registered trademarks	-0.0675 (0.049)	0.6795 (0.352)	0.1815 *** (0.054)	2.0747 *** (0.154)		
Number of registered patents	-0.1231 (0.118)	0.3729 (1.026)	0.0631 (0.107)	1.3161 (0.423)		
Foreign branch	-0.1482 *** (0.037)	0.3392 *** (0.280)	0.0419 (0.038)	1.2611 (0.174)	0.0032 (0.017)	1.1811 (0.450)
Website size	-0.0263 ** (0.012)	0.911 (0.064)	0.0140 (0.016)	1.1283 (0.087)	-0.0024 (0.007)	0.9501 (0.206)
Controls						
<i>Founder demographics</i>						
Founder age	-0.0020 (0.002)	0.9835 (0.011)	-0.0097 *** (0.002)	0.9550 *** (0.010)	0.0011 (0.001)	1.0272 (0.024)
Percentage of males	-0.0002 (0.001)	0.9997 (0.003)	0.0009 (0.001)	1.0045 (0.003)	0.0002 (0.001)	1.0091 (0.011)
<i>Market segment, targeting and positioning</i>						
Pro-social tone	0.1070 *** (0.037)	2.0464 *** (0.239)	-0.0484 (0.044)	0.8809 (0.209)	0.0396 ** (0.017)	3.0593 ** (0.460)
Finance tone	-0.0072 (0.009)	0.9372 (0.056)	-0.0147 (0.012)	0.9703 (0.054)	-0.0085 (0.006)	0.7698 (0.164)
Tech tone	-0.0994 * (0.055)	0.5281 (0.407)	0.1058 ** (0.052)	1.5887 ** (0.209)	-0.0111 (0.025)	1.1934 (0.669)
B2B	-0.0376 (0.046)	0.6547 (0.335)	0.0797 * (0.047)	1.2377 (0.211)	0.0102 (0.019)	1.4999 (0.540)
Limited liability	-0.0630 * (0.037)	0.7268 (0.231)	0.2899 *** (0.056)	5.1331 *** (0.366)	-0.0016 (0.021)	1.3723 (0.574)
Time effects	FE	FE	FE	FE	FE	FE
Sub-segment effects	FE	RE (Gamma)	FE	RE (Gamma)	FE	RE (Gamma)
Observations	892	892	892	892	892	892
Days at risk	2808630	2808630	2507130	2507130	2785170	2785170
Events	163	163	254	254	34	34
Pseudo R-squared	0.2261	0.2686	0.2020	0.2427	0.1819	0.1137
AIC	327.538	1835.84	958.455	3123.2647	802.038	460.6153
Log-likelihood	-111.768	-871.3294	-425.232	-1513.4426	-347.019	-195.0236

TABLE A8

Mediation Results

This table summarizes the mediation analysis results for the average causal mediation effect and the proportion mediated of the total effect of the potential mediator funding by BA/VC investor on firm failure. All models controlled for additional covariates. The reported values in parentheses represent 10% confidence intervals, derived from Monte Carlo simulations with 10,000 draws each. Significance levels for coefficients: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

	Average causal mediation effect		Proportion Mediated	
	Probit	Frailty II	Probit	Frailty II
Dependent: Firm failure				
Professional experience	0.00656 [-0.00747 , 0.00674]	-0.0054 [-0.00767 , 0.00674]	5.02392 [-4.96545 , 4.81015]	0.50938 [-5.79339 , 5.06736]
Number of registered trademarks	-0.02696* [-0.06386 , -0.00571]	-0.02349* [-0.06134 , -0.00655]	0.52984 [-3.02852 , 5.12258]	0.49794 [-3.63317 , 5.50611]

TABLE A9

Heckman selection model

This table presents the results of the regression of a two-step Heckman selection model. Variable definitions are reported in Appendix Table A1. The dependent variable in column (1) is whether at least one of the founders is present on a social media account (LinkedIn, Xing) and results are shown for a probit model (coefficients reported are average marginal effects). Columns (2)–(4) report the second-step Cox proportional hazard regressions for firm failure duration in columns (2), duration to receive funding by BA/VC in column (3) and duration to register the first patent in column (4). Cox model coefficients reported are hazard ratios. Standard errors are clustered at the segment level and are reported in parentheses. Significance levels for coefficients: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

	First Stage		Second Stage	
	(1) Founder social media presence Probit	(2) Firm Failure Cox	(3) Funding by BA/VC Cox	(4) Patent filing Cox
Explanatory				
<i>Founder resources</i>				
Number of founders		0.9916 (0.032)	1.0629 (0.052)	1.5044 (0.258)
Business education		1.0101 (0.011)	1.0268 (0.017)	0.9419 (0.110)
STEM education		0.9961 (0.010)	1.0096 (0.017)	1.1598 ** (0.075)
Alternative education		0.9980 (0.009)	1.0181 (0.015)	0.9764 (0.090)
Entrepreneurial experience		1.0052 (0.007)	1.0224 ** (0.011)	1.0430 (0.047)
Professional experience		0.9840 * (0.008)	1.0168 (0.013)	0.9177 (0.074)
<i>Network resources</i>				
Legal entity among founders	-2.0544 *** (0.414)	1.5149 (0.484)	0.7383 (1.086)	1678.7251 *** (2.821)
Third-party endorsement	0.2821 * (0.160)	0.8484 * (0.095)	1.1331 (0.140)	0.5792 (0.666)
Firm social media presence	0.2628 ** (0.113)	0.9160 (0.066)	0.8979 (0.119)	0.5555 (0.501)
Metropolitan area	0.3730 *** (0.133)	1.0642 (0.086)	1.1222 (0.150)	0.2112 ** (0.698)
Bank density	-0.1311 (0.102)	1.0397 (0.058)	1.0536 (0.109)	0.9020 (0.484)
Fintech density	-0.0016 (0.053)	1.0083 (0.029)	0.9081 ** (0.049)	0.9099 (0.233)
<i>Firm resources</i>				
Number of registered trademarks	0.0982 (0.202)	0.8867 (0.109)	1.6675 *** (0.111)	
Number of registered patents	4.8228 (91.285)	0.7390 (0.327)	1.2251 (0.354)	
Foreign branch	0.2059 (0.147)	0.7139 *** (0.094)	1.1488 (0.134)	0.3999 (0.673)
Website size	0.1748 *** (0.052)	0.9546 (0.038)	1.0741 (0.079)	0.5239 * (0.348)
IMR		0.8654 (0.325)	0.8141 (0.734)	0.0018 *** (1.995)
Controls				
<i>Founder demographics</i>				
Average founder age		0.9950 (0.003)	0.9666 *** (0.007)	1.0448 (0.033)
Percentage of males		1.0003 (0.001)	1.0033 (0.002)	1.0095 (0.014)
<i>Market segment, targeting and positioning</i>				
Competitive strength	-0.0018 (0.006)	0.9962 (0.004)	0.9952 (0.008)	1.0290 (0.025)
Pro-social tone	0.2466 (0.182)	1.2219 ** (0.079)	0.8932 (0.147)	2.4653 (0.600)
Finance tone	0.0258 (0.039)	0.9822 (0.018)	0.9761 (0.037)	0.7568 (0.204)
Tech tone	0.1553 (0.208)	0.8404 (0.126)	1.3735 ** (0.153)	0.6896 (0.830)
B2B	0.4204 * (0.223)	0.8765 (0.111)	1.1727 (0.161)	0.8933 (0.711)
Limited liability	0.3915 *** (0.151)	0.8915 (0.093)	3.0403 *** (0.280)	0.3350 (0.822)
Time-fixed effects	FE	FE	FE	FE
Segment effects	FE	FE	FE	FE
Segment = Asset Management	-0.4061 *** (0.157)	1.1125 (0.101)	0.9577 (0.165)	1.5524 (0.826)
Segment = Financing	-0.4929 *** (0.135)	1.2297 ** (0.096)	0.8268 (0.180)	0.5521 (0.880)
Segment = Payments	-0.1545 (0.162)	1.1298 (0.079)	1.0283 (0.136)	1.5078 (0.578)
Observations	892	892	892	892
Days at risk	2808630	2808630	2507130	2785170
Events	163	163	254	34
Pseudo R-squared	0.3021	0.2671	0.2784	0.1332
AIC	867.8964	2186.4192	3262.5033	633.3646
Log-likelihood	-396.9482	-1046.2096	-1584.2517	-271.6823

FIGURE A1

Overview of the theoretical derived variables, their operationalization, and the key data sources utilized in this study. Please note that we only highlight the significant and dominant data sources.

