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Business Angel Investment, Public Innovation Funding and Firm Growth

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Abstract

In recent years, business angels have invested in a few hundred Finnish firms annually. The target firms are mainly young and small: 75% of them employ fewer than 10 workers and are less than 8 years old. These firms are most likely to be found in the ICT and professional service industries and manufacturing. Although many angel-funded firms have faster employment growth compared to matched nonfunded firms, the average growth rates do not significantly differ when we control for receiving public innovation funding and other firm characteristics. As many as 75% of the firms funded by business angels have also received public innovation funding in some phase, and 57% have received it before angel funding. However, no robust indication was found that combining these two sources of funds would give an extra boost to growth.

Tiivistelmä

Bisnesenkelisijoitukset, julkinen innovaatiorahoitus ja yritysten kasvu

Viime vuosina bisnesenkelit ovat vuosittain sijoittaneet muutamaan sataan yritykseen Suomessa. Kohdeyritykset ovat tyypillisesti nuoria ja pieniä. Noin 75 % kohdeyrityksistä oli iältään alle 8-vuotiaita ja työllisti sijoitushetkellä alle 10 henkilöä. Toimialoista yleisimpiä olivat ICT-palvelut ja muut liike-elämän palvelut sekä teollisuus. Vaikka monien enkelirahoitteisten yritysten työllisyyskasvu oli muita yrityksiä nopeampaa, keskimäärin kasvueroja ei löytynyt, kun huomioimme julkisen innovaatiorahoituksen saannin sekä joukon muita yritysten taustaominaisuuksia. Peräti 75 % enkelirahoitusta saaneista yrityksistä sai julkista innovaatiorahoitusta jossain toimintansa vaiheessa ja noin 57 % oli saanut sitä ennen enkelisijoitusta. Analyyseissä ei kuitenkaan löytynyt vahvaa näyttöä siitä, että sekä enkeli- että julkista innovaatiorahoitusta saaneet yritykset olisivat kasvaneet muita yrityksiä nopeammin.

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Avainsanat: Bisnesenkelisijoitukset, Julkinen innovaatiorahoitus, T&k, Yritysten kasvu

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1 Introduction

A well-functioning financial system offers financing for firms that have positive net present value (NPV) investment projects but, at the same time, distinguishes bad investment projects and poor companies and leaves them without financing. This ideal world does not necessarily materialize in every country and every company.

Governments around the world are particularly anxious about the ability of small- and medium-sized enterprises (SMEs) to receive sufficient funding. Although not all SMEs are innovative, new SMEs often challenge existing paradigms and take advantage of various opportunities neglected by established companies (Baumol, 2002). Another motive of governments concerns the role of SMEs in job creation. In most EU countries, SMEs have experienced the highest employment growth (de Kok et al., 2011).

One special kind of financing is equity funding by business angels. Angel investors are wealthy individuals who invest their personal funds in private firms without family connections. Typically, business angels are seasoned entrepreneurs or managers with entrepreneurial backgrounds (R. T. Harrison & Mason, 1992). Angels invest their time, expertise, and money in young and growth-oriented ventures, and in return, the angels receive an ownership share of the company. Angels are hands-on investors; in addition to finance, they bring expertise and knowledge in the form of advice and support (Sohl, 1999). They also provide authority by participating in the firms' boards of directors (Wiltbank, Read, Dew, & Sarasvathy, 2009). Consequently, angels can contribute to the operations, strategies, and eventual future outcomes of the firms they finance. Angels therefore act as informal venture capitalists (Wiltbank et al., 2009). In terms of timing, angels are the first professional outside investors to become involved after owners and informal investors – family, friends, and fools. Nonetheless, while angel investment markets long ago surpassed venture capital markets in terms of size in many countries, such as the United States, our understanding of angel investing remains incomplete (Gompers & Lerner, 2001; Lerner, Schoar, Sokolinski, & Wilson, 2018).

In addition to angel investments and other private financing, governments often provide funding for new ventures, particularly R&D activities. One rationale for such funding concerns financial constraints. Another rationale relies on positive spillovers, which, in turn, induce underinvestment in R&D below what is socially desirable.

There are at least two mechanisms for the interaction of public R&D funding and early-stage investing. First, public R&D funding decisions could convey positive information about the viability of technology to private investors (Lerner, 1999; Takalo & Tanayama, 2010). Second, public funding or R&D subsidies themselves potentially transform a project's NPV from negative to positive.

To our knowledge, only a few studies have analyzed the interaction between public R&D funding and early-stage private financing. Lerner (1999) analyzes the Small Business Innovation Research (SBIR) program, which has provided funding to small high-technology firms in the U.S. His results suggest that SBIR awardees grew faster and were more likely to receive venture financing. A more recent study focuses on the U.S. Department of Energy's SBIR program. In that study, Howell (2017) shows that SBIR awards increased the probability of receiving subsequent angel or venture capital funding; furthermore, she finds that the early-stage awards had a positive effect on the firms' patenting and net sales. However, there exists some evidence that the relationship of private and public funding seems not to be only a one-way street. Venture capital (VC) -backed firms are more likely to participate in EU-funded R&D partnerships than their non-VC-backed peers (Colombo, D'Adda, & Pirelli, 2016).

Finnish evidence is scarce, but it is consistent with these observations. Pajarinen, Rouvinen, and Ylhäinen (2016) document that as many as 39% of venture capital -backed companies had obtained public innovation funding in the three years before their first investment from venture capitalists. In the three years after the first VC investment, 15% of companies had received innovation funding from the public sector.

This study focuses on business angels and companies backed by them. We pay special attention to the interaction between angel investments and public research, development and innovation (R&D&I) funding.

Our main research questions are as follows:

- What is the role of business angels in the Finnish financial system?
- What is the relationship between public R&D&I funding and business angel investments?
- What is the impact of business angel funding and public R&D&I funding?

This report proceeds as follows. Section 2 provides a literature review of business angel investments. Section 3 describes our dataset. Section 4 provides econometric analyses of the impact of business angel investments and its interaction with public R&D&I funding. Section 5 concludes the paper.

2 Literature review

2.1 Background

Angels operate in the seed and early stages between the informal sector and the formal venture capital sector (Freear & Wetzel, 1990; Sohl, 1999). Unlike venture capitalists, business angels do not manage formal funds on behalf of outside investors. Angels differ from crowdfunding in that they are clearly professional, participate actively and have a significant ownership share in their investments. Nonetheless, angels are a heterogeneous group: the business angel term can be associated with a wide spectrum of investors, including individual angels, business angel groups or networks, and "super angels" – professional investors who are an intermediate form of angels and venture capitalists. Angels invest in risky ventures that have a high probability of failure and a relatively small probability of generating outstanding returns (Mason & Harrison, 2002). Angels screen numerous potential projects and finance only a small fraction of them. In this process, angels also provide valuable guidance for rejected projects and conduct screening activities that are an essential part of well-functioning financial markets. Angels provide mainly equity funding; their return to the investment arises primarily from the valuation increase in the equity stake from the time of investment until exit.

Investments made by wealthy individuals into seed- and early-stage companies are not a new occurrence. For instance, it has been documented that much of the financing for new inventions during the second industrial revolution in the late 19th and early 20th centuries – the dawn of new innovations related to electricity, steel, petroleum, chemicals, and automobiles – came from local informal investors, who took long-term stakes in startup companies (Lamoreaux, Levenstein, & Sokoloff, 2008). The rise of more organized and formal angel investment markets is a more recent phenomenon; angel investments are increasingly organized in semiformal networks (Kerr, Lerner, & Schoar, 2014). The markets for early-stage financing have altogether been in transition; there has been a rise in angel networks or angel groups, super angels, and online platforms for investments (Lerner et al., 2018). As venture capital in many countries has focused on later-stage investments in the aftermath of the financial crisis, the role for other early-stage investors has increased (OECD, 2011; K. E. Wilson, 2015). The rising trend of more structured and professionalized angel investments that utilize pooled resources has resulted in professional angels whose investment practices resemble those of venture capitalists more than those of traditional angels (Ibrahim, 2008).

A distinguishing feature of the angel investment market relates to its opaqueness and the fact that much of it remains hidden from statistics. This opaqueness is understandable given the private nature of the market and the desire for anonymity and privacy on the part of the angels. Indeed, angel investment markets are only partly visible and are constituted largely by "invisible markets" that are challenging to measure (Mason & Harrison, 2000; OECD, 2011). Angel investment markets have traditionally operated in almost total obscurity, and these markets have been very heterogeneous and localized (Prowse, 1998). Informal investment markets often consist of regional networks of investors, suggesting that information in these markets is likely to be derived from local sources (Sohl, 1999). While much angel investing remains local, a nonnegligible minority share of investments are made into firms located further away from the investor (R. Harrison, Mason, & Robson, 2010). Either way, the monitoring costs are likely to be lower for local firms in comparison to more distant firms (Lerner, 1995). Hence, the local proximity of investments is likely to be a relevant matter for hands-on investors such as angels.

Angels invest in projects associated with high uncertainty. The investments of business angels have a negatively

skewed return distribution (Mason & Harrison, 2002): Findings from the United Kingdom indicate that approximately half of these investments are loss-making or break even, whereas only 10% of these investments generated internal rate of returns (IRRs) exceeding 100%. In comparison to the return profile of early-stage venture capital funds, business angels have a lower share of loss-making investments, a higher share of investments that perform poorly or moderately, and a similar share of well-performing investments. Because of their limited chances for diversification, angels attempt to avoid bad investments more than they try to "hit a home run". The most common means of exit is trade sales. Mason and Harrison (2002) suggest that angels hold their investments for a relatively short time period, averaging four years for successful investments. In principle, angels could be more patient investors than venture capitalists, given that they invest their own funds and are not constrained by the need to exit within a limited and predefined time horizon (Croce, Guerini, & Ughetto, 2018). Indeed, Sohl (1999) suggests that angels provide patient capital and make relatively long-term investments, typically in the range of 5 to 7 years.

2.2 Financial contracts of angels and venture capitalists

What kind of contracts do angels and venture capitalists utilize? Kaplan and Stromberg (2003) analyze the real-world contracts of VCs in light of financial contracting theories. These authors document that VC financing allows VCs to allocate cash flow, board, voting, and liquidation rights, as well as other rights. The rights are contingent on measures of performance. Control rights are allocated so that in case of poor performance, the VC obtains full control. When performance improves, the entrepreneurs regain more control rights. In the case of good performance, VCs retain cash flow rights but forgo control and liquidation rights.

Business angels have traditionally used simple and informal contracts that lack the common protections of contracts used by VCs, despite the extreme risks associated with their investments (Ibrahim, 2008). While common wisdom suggests that this choice of contracts reflects the unsophistication of angels, Ibrahim (2008) suggests that this view is unwarranted: A closer examination reveals that angel contracts are rationally designed to achieve both financial and nonfinancial objectives. First, rational angels recognize that venture capitalists could be hesitant to invest if they need to unwind overreaching angel preferences to obtain their own standard preferences. Hence, rational angels avoid losing their upside and act accordingly. Second, angels' informal screening and monitoring methods are warranted as they substitute more formal VC contracts. Angels economize on screening by making local and relationship-driven investments, and they economize on monitoring by actively participating in company development. Third, angel contracts are rational due to costly contracting; it is not cost-effective to design complex contracts for small investment amounts. Fourth, angels invest their personal funds and therefore have more flexibility in terms of time horizon. Angels may even have nonfinancial reasons for their investments.

The more complex contracts utilized by angel groups can also be rational (Ibrahim, 2008): Indeed, angel groups have more similarities to venture capitalists than with traditional angels. First, angel groups are more professional and invest larger sums at a somewhat later stage. Second, angel groups have fewer chances for informal screening and monitoring compared to traditional angels due to their more distant nature in relationship terms. Hence, angel groups need to mitigate this issue with contract terms. Third, given the higher investment amounts and longer duration, higher transaction costs are justified. Fourth, angel groups' private benefits are not negatively affected by using more detailed contracts. Overall, the rise of more formalized angel group investing has resulted in significant changes to the angel investing paradigm.

2.3 Business angels and investment decisions

Who becomes an angel investor, and what kind of factors do angels pay attention to when making investments? Understanding the decision-making processes of angel investors could prove useful for policymakers, who attempt to address potential funding gaps in markets characterized by extreme risks and high rejection rates. Empirical findings suggest that the propensity to make microangel investments is affected by entrepreneurial experience and skills, personal familiarity with entrepreneurs, and gender (Maula, Autio, & Arenius, 2005). These findings

suggest a role for networks and matchmaking services of firms and individuals with an entrepreneurial background in the promotion of informal venture capital markets.

There is a question of whether early-stage investors such as angels or venture capitalists should place more emphasis on business than on management in their investment decisions. Kaplan, Sensoy, and Strömberg (2009) study the evolution of firms from business plans to public companies and note that firms' business lines remain surprisingly stable, while turnover in management is substantial. Furthermore, these authors find that management turnover is positively associated with the formation of alienable assets (i.e., patents and physical assets). Based on these findings, these authors suggest that investors should place more emphasis on business than on management.

However, the actual selection criteria utilized by early-stage investors provide rather contrary views. Bernstein, Korteweg, and Laws (2017) conduct a randomized experiment to study which firm characteristics matter most for early-stage investors. They find that investors focus mostly on information on a startup's founding team rather than on firm traction or existing lead investors. Investors rely on strong team members not only because of signaling but also because of operational reasons. Taken together, the findings highlight the importance of human capital to the funding and the eventual success of early-stage firms. J. Block, Fisch, Vismara, and Andres (2019) also analyze the investment criteria of private equity investors. These authors suggest that the most important investment criteria are revenue growth, value-added products and services, and the track record of the management team. Business angels and venture capitalists focus less on current profitability and instead pay more attention to scalability.

The decision-making process of angels has been analyzed in the context of decision-making models. Maxwell, Jeffrey, and Lévesque (2011) suggest that business angels do not apply comprehensive decision models that weight and score numerous attributes. Instead, they apply shortcut decision-making heuristics in the initial selection stage to reduce the potential number of financed projects. After that, they may use a different set of selection criteria in the final decisions and not necessarily utilize the criteria that were initially considered critical.

Early-stage investors have an important role in affecting the strategy and future outcomes of their target firms: Wiltbank et al. (2009) study angel investors' use of predictive and nonpredictive control strategies and document that the use of these strategies matters for venture performance. Angels emphasizing prediction make larger investments, and those using nonpredictive control strategies exhibit fewer failures but do not experience a smaller number of successes.

Business angels often syndicate their investments with other angels. Angel investments are increasingly made through semiformal networks of wealthy individuals with entrepreneurial backgrounds (Kerr et al., 2014). The angel network members meet at regular intervals for pitching events to hear entrepreneurs pitch their business ideas. After such pitches, angels decide on further due diligence and then whether to invest in the firms. Carpentier and Suret (2015) analyze the decision-making process of Canadian angel group members. These authors suggest that the decision-making process and criteria of angel groups differ from the decision-making process of independent angels. In their decision-making, angel groups aim to control market and execution risk. In this process, angel groups favor investment strategies that focus on early exits and that reject inexperienced entrepreneurs. The rejections are often based on proposals and occur even before the first presentation of the project. Only a few entrepreneurs meet angel group members face-to-face in this process. The pitched projects are mostly rejected during informal analyses, meetings, and discussions rather than immediately after the presentations. Rejections of proposed projects after the prescreen stage are usually related to product and market strategy reasons rather than weak management. The finding that angels group members pay more attention to market and execution risk than agency risk suggests that these groups utilize a similar approach to the one adopted by venture capital investors.

Bonini, Capizzi, Valletta, and Zocchi (2018) study the effects of business angel network membership on the investment decisions of the network members. First, these authors find that business angel network membership is positively associated with the share of angels' personal wealth allocated to angel investments. Second, they find that business angel network membership is negatively associated with the equity stake of angels in the target

firms as measured by the net asset value. These authors suggest that angel affiliation provides benefits related to information, diversification, larger deal flow, networking, and monitoring. However, the decision to syndicate investments differs from person to person, and some angels may prefer to invest alone rather than syndicate investments; J. H. Block, Fisch, Obschonka, and Sandner (2019) analyze the relation between angel investors' personality traits and syndication, suggesting that extroversion increases and conscientiousness decreases the likelihood of syndication. Angel personality traits do not appear to affect venture performance.

Matchmaking services facilitate the meeting of entrepreneurs and angel investors. Governments have provided support for building business angel networks under the assumption from conventional wisdom that such networks cannot operate on a for-profit basis – an assumption challenged by the rise of private business angel networks (Collewaert, Manigart, & Aernoudt, 2010; R. T. Harrison & Mason, 1996). Collewaert et al. (2010) suggest that business angel networks diminish the informational problems and financial constraints faced by entrepreneurial firms. In their Belgian sample, the authors find that the vast majority of angel investors and entrepreneurs would not have known each other without business angel networks. Regarding concerns related to deal quality, these authors also suggest that business angel networks do not appear to attract worse-quality deals than other angel financing channels. However, evidence on the effectiveness of business angel networks is still largely lacking (OECD, 2011).

2.4 Treatment effect evaluation

In the following, we discuss the problem of evaluating the causal effects of financing provided by business angels, venture capitalists and private equity investors alike. Similar evaluation problems also arise in studies analyzing the effects of R&D subsidies. The evaluation of the treatment effects of angel funding is complicated, and careful consideration is needed when attempting to estimate the causal effects of such funding. There is a fundamental problem arising from the fact that one cannot observe the alternative state of the world – what would have happened to an angel-funded firm in the absence of such funding. A superior performance of funded firms over nonfunded ones could reflect successful selection or incremental value-added by angel investors: from the point of view of policy, it is essential to distinguish between these alternatives (Lerner et al., 2018).

The evaluation of treatment effects is further complicated by several issues. First, firms are heterogeneous and can choose whether to apply for funding. Angel investors, in turn, decide whether to fund firms, and they rarely make this decision in a random fashion. Consequently, there is a problem arising from selection that could originate from the side of either entrepreneurs or investors. The closely related empirical literature on venture capital suggests a key challenge in the evaluation of such effects: the distinction between selection and treatment effects (Da Rin, Hellmann, & Puri, 2013). Both of these effects are likely to be relevant. Venture capitalists and angels screen their investments, provide active support for the firms and monitor them after capital infusion. A mere correlation between funding and venture success does not provide an indication of the treatment effects as some – possibly unobserved – company characteristics could drive the performance. Therefore, performance differences between angel-backed and non-angel-backed firms might not reflect treatment effects but suggest that certain kinds of firms select into angel funding. That is, the firms could have been successful even in the absence of such funding. In the empirical angel literature, there are also typically issues related to data availability and difficulties in finding a suitable control group of firms that are otherwise identical to funded firms. Survivorship bias would also be a problem if only successful firms are observed, while failed firms drop out of the sample altogether.

The real-world empirical setups in private equity research are often far from the ideal of randomized experiments, the gold standard of treatment evaluation. However, controlling for selection bias is challenging. In laboratory studies, participants could be allocated randomly to the treated and nontreated groups. Because of such randomization, the characteristics of the treated and nontreated individuals would be similar. Consequently, the observed effects could be more cleanly interpreted as causal effects. In the absence of such randomization, the evaluation of treatment effects is complicated. Nonetheless, several methods have been developed to address these kinds of evaluation problems:

The method of *matching* selects matched control firms of similar observed characteristics to treated firms. Another possibility is to utilize *instrumental variable* estimation, in which one has to find an instrumental variable that is correlated with the endogenous variable (e.g., financing decision) but not directly associated with the dependent variable (e.g., growth or patenting). In the search for instruments, one possibility is to utilize "natural experiments" such as exogenous changes in the legal environment. Such institutional changes could provide exogenous variation in venture funding, such as institutional changes in the 1970s and 1980s that allowed the allocation of pension funds to venture capital investments (Kortum & Lerner, 2000). The *difference-in-differences* approach compares the differences in treated and control groups over time under the assumption that the unobserved differences between the treated and nontreated firms are constant over time and that both groups face similar trends. *Regression discontinuity design* utilizes natural discontinuities such as policy rules that divide firms into natural treatment and control groups. The comparison of treated and nontreated firms very close to the boundary could result in a setup where both groups are very similar to each other. In an ideal scenario, such an empirical setup could be – under certain assumptions – as good as a randomized experiment.

2.5 Effects of angel funding

What kinds of real effects do early-stage investors, such as angels and venture capitalists, have on their target firms? Much of the current knowledge of these issues arises from the venture capital literature. According to conventional wisdom, venture capitalists help overcome informational problems by various means, including screening and monitoring, utilization of control rights and provision of value-added services that professionalize the operations of firms and improve their governance (Chemmanur, Krishnan, & Nandy, 2011; Hellmann & Puri, 2000; Kaplan & Stromberg, 2003; Kerr et al., 2014). Consequently, venture capital–funded firms show better performance in terms of survival, productivity, commercialization, and successful IPO or mergers and grow to a larger scale than nonventure capital–funded firms (Chemmanur et al., 2011; Croce, Martí, & Murtinu, 2013; Puri & Zarutskie, 2012). While the superior performance of venture capital–backed firms could be driven by both the screening and monitoring effect (Chemmanur et al., 2011), there is evidence of a value-added effect provided by venture capital that appears to be long-lasting – venture capital "imprints" the firms (Croce et al., 2013). Nonetheless, the effects of angel financing are less well known, and few studies have been able to address the issue of causality in a particularly credible way.

Kerr et al. (2014) provide an analysis of the effects of angel group financing by utilizing a regression discontinuity design and data from the United States. Their analysis exploits discontinuities (i.e., discrete jumps) in the probability of angel funding imposed by small changes in the collective level of interest of angels arising from the voting process of angel group deals. At the margin, a difference of one angel voting either in favor or against the deal could make or break the deal. By comparing very similar firms on the opposite sides of the funding threshold, there is a smaller chance that unobserved differences drive the results. These findings suggest that angel financing has a positive effect on the survival, employment, patenting, and website traffic of angel-funded firms. The results suggest no significant effect on the follow-up funding in the sample comparing ventures just above and just below the funding threshold. These authors suggest based on their findings that financing may not be the most important contribution provided by angels. Instead, some other aspects, such as the consulting and networks provided by the angels, could be more important.

Lerner et al. (2018) analyze an international sample of angel group investments using a regression discontinuity design following the approach used by Kerr et al. (2014). In their approach, these authors compare firms just above and just below the funding threshold under the assumption that the deals are quasirandomly assigned at the discontinuity. Therefore, the just-funded and just-rejected deals should be very similar to each other. These authors find that angel investments have a positive effect on firm growth, performance, and survival, as in the analysis based on the U.S. data. These findings for the international sample also indicate that angel funding has a positive effect on follow-up funding, in contrast to the U.S. findings. The evidence based on international data suggests that angels could serve as a more pronounced gateway for follow-up funding in countries other than the U.S. These effects are independent of countries' venture capital activity and entrepreneurship friendliness.

However, the environment affects what kind of firms select into financing: in less developed environments, only more developed firms apply for angel funding, and they also attempt to raise lower amounts of angel funding. These findings could indicate that early-stage firms become discouraged in less developed environments and self-reject themselves.

A small number of studies analyze the effects of angel financing using European datasets. Bonini, Capizzi, and Zocchi (2019) analyze the postinvestment performance of Italian angel-backed firms. These authors construct a performance index based on alternative performance metrics (revenues, net asset value, and net income) as their measure of interest. In this way, they attempt to overcome the issues of small samples and possibly conflicting individual measures. The empirical findings suggest that the performance and survival of angel-backed target firms is positively associated with the presence of angel syndicates and hands-on involvement of angels. Furthermore, the performance and survival of angel-backed firms appear to be negatively associated with monitoring effort and fractioning of equity provision.

Levratto, Tessier, and Fonrouge (2018) study a sample of angel-backed firms from France. They analyze the growth effects of angel funding focusing on three alternative growth measures: employment, sales, and tangible asset growth. These authors utilize OLS and quantile regressions using two alternative control samples: First, they compare angel-backed firms to randomly selected controls. Second, they compare angel-backed firms to the firms' nearest neighbors. They find that angel-backed firms perform better than randomly selected control firms. However, the findings suggest that angel-backed firms do not grow significantly better than otherwise identical control firms.

2.6 Angels, venture capital and crowdfunding

Are angel funding and venture capital complements or substitutes, and how do these different investor types interact? According to conventional wisdom, angels invest in the same high-risk and growth-oriented startup firms as venture capitalists but at an earlier stage (Freear & Wetzel, 1990; Hellmann, Schure, & Vo, 2017; Ibrahim, 2008). In this way, angels are an essential part of the venture capital process, as they provide a bridge between informal finance and venture capital (Ibrahim, 2008). Hence, conventional wisdom suggests that angels and venture capitalists complement each other. However, the relationship of these two investor groups could be somewhat complicated. Hellmann and Thiele (2015) analyze the interaction between angel funding and venture capital in a theoretical framework. In this framework, the early-stage and later-stage funding of an entrepreneur is provided by two different investor types. The entrepreneur first obtains funding from angels and later from VCs. Consequently, the two investor types are "friends" in the sense that they rely on each other: Angels rely on VCs in the later stage as a source of follow-up funding given their own limited funds, while VCs rely on angels to provide them with deal flow. However, these two investors are "foes" in the sense that the VC no longer needs the angel in the later period. Stories of "burned angels" indeed suggest that VCs may exploit their market power and provide low valuations.

Kim and Wagman (2016) theoretically analyze entrepreneurs' choice between angel finance and venture capital. In this framework, markets are competitive, and the entrepreneur attempts to retain the ownership share and equity value. The analysis builds on the idea that the decision of the informed investor not to participate in subsequent investment rounds provides a negative signal to the market. When entrepreneurs are *ex ante* identical, they retain a higher equity share when obtaining their funding from angel investors, who commit not to participate in the future round, than when obtaining their funding from venture capital investors. However, when entrepreneurs differ from each other *ex ante* in terms of success probability, a separating equilibrium arises. In this case, higher-quality entrepreneurs obtain funding from venture capitalists, and lower-quality entrepreneurs obtain funding from angels in the first investment round.

While common wisdom suggests that firms first resort to angel funding and afterwards obtain venture capital, an alternative view suggests that angel funding may not merely precede venture capital. Instead, angel funding and venture capital funding could be substitutes that cater to a different set of companies. This alternative view suggests that a different group of firms select into angel financing than into venture capital financing. Hellmann

et al. (2017) study the interaction of different investor types using a sample of Canadian firms. Their findings suggest that angel funding and venture capital funding are dynamic substitutes and that there appears to be selection at work: different funding sources attract different firms. VC-funded firms are less likely to resort to angel investments and vice versa. These findings appear to be contrary to the conventional wisdom that angels merely precede venture capital. Instead, these findings suggest "parallel streams" with relatively little interaction between the VC-backed and angel-backed tracks. These different development paths could have policy implications if VC-oriented policies do not reach firms more suited to angel finance.

Dutta and Folta (2016) evaluate the value-added benefits of private equity investors and compare the effects of venture capitalists and business angel groups. These authors find that both VCs and angels have a positive effect on innovation. However, this effect is nonadditive. That is, there is no additional impact if the funded firm has already obtained funding from the other investor type (i.e., angel or venture capitalist). Furthermore, there appears to be a performance difference between firms funded by angel investors and venture capitalists. Specifically, the authors document that firms funded by venture capitalists have more significant innovations and faster commercialization rates. Finally, firms funded by venture capitalists have faster exits through IPO or acquisition than angel-funded firms do.

The markets for early-stage finance have been in transformation given the rise of digital crowdfunding and angel platforms. These platforms allow individual investors to make investments into startup firms, and they could diminish the costs associated with such investments. Crowdfunding platforms have experienced growth in recent years and represent a significant market segment in countries such as the United Kingdom (Wang, Mahmood, Sismeiro, & Vulkan, 2019). Following the rise of equity crowdfunding, digital platforms are attracting not only nonprofessional individual investors but also business angels and other professional investors. Wang et al. (2019) analyze the interaction of angels and crowdfunding investors using data from a crowdfunding platform. These authors document that high-contribution pledges have a positive relation with the number of subsequent pledges. Furthermore, high-contribution pledges made by angels are more effective in that regard compared to pledges made by the crowd. Overall, the findings suggest complementarity between angel and crowd investors.

2.7 Angels and public policy

Government interventions in the angel and venture capital markets build on the presumption of the existence of market failures. Such market imperfections could hinder firms' access to capital and impede their R&D activities (Hall & Lerner, 2010). In general, the policies for encouraging the financing of young innovative firms are based on two key assumptions (Lerner, 1998, 2002): The first assumption is that the private sector provides insufficient financing for such firms. Problems of asymmetric information – issues related to *adverse selection* and *moral hazard* – could hinder firms' access to capital, and these problems could be acute among young and small innovative firms (Hall & Lerner, 2010). *Adverse selection* would arise in a situation where bad entrepreneurs are more likely to apply for funding. *Moral hazard* refers to a situation where the entrepreneur misbehaves after getting funding and uses the funds for other purposes than those expected by the financier. Consequently, when financiers cannot distinguish good firms from bad ones, even good firms face less favorable financing terms than they would face otherwise. In the extreme case, such markets may even disappear altogether. The second assumption is that the government can identify socially or privately desirable projects that provide high returns or is able to encourage private financial intermediaries to do so (Hall & Lerner, 2010). Through intervention, the argument goes, the government could overcome the financial market imperfections faced by firms and generate positive R&D spillovers that would benefit society at large.

Lerner (1998) discusses the rationales for public efforts to support angel investments: There is an ambiguity in whether government should encourage investments by individual or angel investors. Because of the existence of specialized financial intermediaries (i.e., venture capitalists), it is not clear whether subsidizing individual investors would be desirable and increase welfare. Venture capitalists specialize in solving problems of asymmetric information exactly in the case of young businesses. One could therefore plausibly ask whether less-professional

and less-specialized investors would be able to do better than specialized financial intermediaries. Nevertheless, there is also literature suggesting that young and small technology-oriented firms could be vulnerable to financial market imperfections and lack sufficient capital (Hall & Lerner, 2010; Lerner, 1998). Venture capitalists back only a small fraction of such firms, and the structure of venture capital may not fit all firms, suggesting a potential role for other investors.

There are several potential rationales for promoting angel markets, informal venture capital markets (Mason, 2009): First, the cost structure of business angels differs from the cost structure of venture capital funds, allowing angels to make smaller investments to seed and early-stage business below the minimum threshold deal size required by venture capital funds. Second, the local presence of angels could potentially overcome regional funding gaps. Third, angel funding is "smart money"; angels make hands-on investments and contribute by providing not only finance but also advice and contacts to their target firms given their experience and entrepreneurial background. Such investments could be beneficial to firms. Fourth, there is a belief that there is a scope for expanding the supply of angel finance. However, very little is known about the effects of public policies targeted to informal venture capital markets, given their opaque nature and the lack of data.

Many public efforts to boost entrepreneurial activity and venture capital have failed, casting doubt on the role of government in subsidizing such activity (Lerner, 2009). Lerner (2010) provides some key guidelines for policy initiatives that attempt to promote the markets for entrepreneurial finance: First, one needs to recognize the importance of the entrepreneurial environment, as there could be other potential barriers to entrepreneurial activity than money. Second, policy initiatives designed for financing early-stage ventures should let the markets provide the direction and help to avoid misguided policy actions. Third, government programs should avoid the temptation to micromanage. Limiting the flexibility of entrepreneurs and investors with excessive requirements could be detrimental.

There have been various policy developments that attempt to foster angel investments but whose effects still remain largely unexamined (Lerner et al., 2018): First, there is a rise in coinvestment funds for seed- or early-stage equity capital to develop and professionalize angel investment markets. Second, tax incentives have been provided to encourage angel investments. Third, investor training programs have been provided for angels. Fourth, there has been direct funding for incubators, accelerators, and other matchmaking services. In the following section, we discuss the existing empirical literature on the role of R&D subsidies and tax incentives in the context of informal and formal venture capital.

2.7.1 Subsidies and early-stage capital

Little is known about the effects of government subsidies on startup firms' access to informal venture capital or the joint effects of subsidies and angel investments on the performance of firms. Nonetheless, there are some existing studies that have addressed the role of R&D subsidies in the context of firms' access to more formal venture capital.

Takalo and Tanayama (2010) theoretically show that public R&D subsidies could, under certain assumptions, diminish the financial constraints faced by technology-based small businesses: First, the subsidy itself could lower the cost of capital faced by firms. Second, the R&D subsidy granted for an innovation project could provide an informative signal to private financiers about the quality of the project. Hence, public R&D subsidies could have a role in certifying firms to private financial intermediaries, in line with the certification hypothesis (Lerner, 1999, 2002).

In an analysis focusing on the United States, Lerner (1999) studies the effects of SBIR subsidies and observes that subsidized firms had faster employment growth than control firms. Subsidized firms were also more likely to attract private venture capital. The outperformance of subsidized firms was limited to high-technology firms and regions associated with significant venture capital activity. There was no performance increase from obtaining multiple subsidies. These findings indicated that innovation subsidies could have a role in certifying firms, although there is also evidence of distortions in the application process. In a more recent study, Howell (2017) provides a regression discontinuity design analysis on the effects of SBIR subsidies granted for energy sector startups. The results indicate that early-stage subsidies double the probability of obtaining

subsequent venture capital. The subsidies also have a positive effect on patenting and revenue. The effects are stronger for more financially constrained firms. These effects appear to arise because subsidies allow technology prototyping.

Pajarinen et al. (2016) analyze the interaction of private equity firms and Tekes – the Finnish Funding Agency for Technology and Innovation. These authors suggest that there is a symbiotic relationship between the government agency and private venture capital firms – they complement each other. The timing of the subsidies and private venture capital investments indicates that Tekes usually operates in earlier stages than private venture capitalists and can therefore feed potential firms to private investors who activate in the next stage of the target firm's life cycle. The survey conducted for private equity investors reasserts this view: Venture capital investors consider the role of Tekes as relevant for their investment decisions, whereas buyout investors consider that Tekes has less relevance for their investment decisions. Both investor groups agree that the role of Tekes is in early-stage innovation funding and that private equity investors join in commercialization or later stages.

2.7.2 Tax incentives

Taxes on capital gains are an important factor affecting both entrepreneurs and investors. Taxes affect entrepreneurial risk-taking by affecting incentives through various channels; these include differences in business and wage income tax rates, asymmetries in the treatment of marginal tax rates on losses and profits, and risk-sharing with the government (Cullen & Gordon, 2007). Lower capital gains tax rates versus other income types have been rationalized by the need to subsidize new ventures (Poterba, 1989). Poterba (1989) discusses the role of capital gains tax policy in the context of entrepreneurial firms that are funded through the venture capital process. The study provides two main arguments: First, most of the funds to startup firms are provided by investors who do not face an individual capital gains tax and are therefore unaffected by it. Second, most taxed capital gains originate from other investments than those made into startup firms. Therefore, a wide-scale capital gains tax reduction would be an imprecise instrument to subsidize new ventures compared with a more targeted capital gains tax reduction. However, whether there is, in fact, a need to subsidize new ventures is another issue.

Keuschnigg and Nielsen (2004) provide a theoretical analysis of startup funding with double moral hazard. In this framework, entrepreneurs have ideas and technical competence but no own resources or commercial experience, while venture capitalists provide finance and advice. Both agents therefore contribute to success, but neither one's effort is verifiable. Consequently, there is a bias towards inefficiently low effort and advice by the agents in the market equilibrium. In this case, even small capital gains taxes have negative incentive effects and result in welfare losses by worsening the existing distortion. The analysis hence suggests that capital gains taxes could be a key factor impeding the development of high-quality risk capital markets. The authors discuss several alternative policy solutions, such as narrowly focused and self-financed tax relief for venture capitalists that would turn out to be welfare-increasing.

Aside from theoretical analyses, there are some empirical analyses on the role of capital gains taxes on venture investors. Gompers and Lerner (1998) document that venture capital commitments by taxable and tax-exempt investors are sensitive to changes in capital gains tax rates. Lower capital gains tax rates are associated with more venture capital commitments. However, this effect appears to arise from increased demand for venture capital, as lower taxes incentivize more people to become entrepreneurs and higher-quality projects come to market. Da Rin, Nicodano, and Sembenelli (2006) analyze the effects of various policy instruments that attempt to foster active venture capital markets. These authors suggest that policymakers should consider a wider range of policies than simply allocating more funds to venture capital markets. For taxation, their empirical estimates suggest that a reduction in the corporate capital gains tax has a positive effect on high-technology and early-stage investments. Specifically, their findings indicate that lower taxes provide better incentives to invest in high-tech and early-stage projects in comparison to low-tech and later-stage projects.

Many countries have increasingly utilized tax incentives targeted at angel investments (OECD, 2011; K. Wilson & Silva, 2013). Fiscal incentives for angel investors may include front-end or back-end tax incentives. Front-end tax incentives relate to tax deductions on investments in seed- or early-stage ventures that lower the real cost of investment. Back-end tax incentives relate to tax relief

on capital gains that could include the rollover or carrying forward of capital gains and losses. In principle, tax incentives could have positive effects by increasing the money allocated to angel investments (Mason, 2009; Maula, 2007). Anecdotal evidence from the often-cited tax incentives scheme implemented in the UK – the Enterprise Investment Scheme (EIS) – appears to suggest that the program generated some degree of additionality (Mason, 2009; OECD, 2011). Furthermore, tax incentives could be particularly important for angels and venture capitalists because of their portfolio approach to investing – many of their investments will fail and hopefully some of the investments will succeed (OECD, 2011). That said, given the high variability in institutional environments, evidence on the effectiveness of tax incentives in other countries could be difficult to reconcile with other environments.

There is limited evidence on the effectiveness of tax incentives targeted at business angels – further analyses are needed to address the desirability of such programs (Carpentier & Suret, 2016). Tax incentive schemes are complex and expensive to administer, uncertainty of eligibility criteria could make such schemes less desirable from the point of view of investors, and investors could possibly distort the schemes with risk-shifting behavior (Mason, 2009). Furthermore, the usefulness of tax incentives – such as the possibility to defer capital gains – depends on the state of the economy and on the possibility to find suitable investments (Mason, 2009). As in the case of other government interventions, tax incentives could have some unintended consequences that need to be addressed in design. Tax incentives may be an imprecise instrument that could be difficult to target in an efficient manner – the schemes need to be designed carefully, and they require monitoring and evaluation (OECD, 2011). Angel investors are special because they provide not only financial resources but also advice and contacts for their target companies. There is a danger that providing tax incentives for wealthy individuals could attract passive financial investors (i.e., "dumb money") who lack the incentives or competence to provide the essential hands-on support that angels can provide to their target firms (Mason, 2009; OECD, 2011).

2.8 Discussion

In sum, business angels act as informal venture capitalists between informal investors – family, friends, and fools – and the formal venture capital sector, providing an essential bridge in the venture capital process. Like venture capitalists, angels are active investors who provide expertise and know-how in addition to money. Because of limited data availability and few studies addressing such data with the necessary rigor, little is known about the real effects of angels. Even less is known about the effects of public policies targeting the informal venture capital sector and its target firms. The existing econometric evidence, focusing particularly on professional angel groups, suggests that angels have a positive effect on the performance, growth, and survival of firms (Kerr et al., 2014; Lerner et al., 2018).

As for policy, many factors affect the functioning of informal and formal venture capital markets. While policy actions aimed at informal venture capital markets are one instrument in the toolbox, it is essential to recognize that well-functioning risk capital markets are dependent on the efficient and competitive business environment in its entirety. More research is called for on the effectiveness of various forms of public interventions targeting informal and formal venture capital markets.

3 Descriptive analysis of target firms

In this study, we utilize several sources of firm-level data, including FiBAN (the Finnish Business Angels Network), Statistics Finland, Asiakastieto and Business Finland.

The data regarding business angels' investments are based on FiBAN's annual statistics. The data include FiBAN members' investments in firms both abroad and in Finland and cover the years from 2013 to 2018. As we are interested in Finnish firms, we have excluded investments abroad.

In most cases, the FiBAN data include company names of funded firms as an identifier, but only for some of them are business identity codes ("y-tunnus" in Finnish) read-

ily available. To merge the data with other firm-level data sources, we search for each target firm's business identity code from the official business register. By carrying out both computer code–based and manual searches, we find the codes for 84–92% of the firms depending on year (see Table 3.1). The investment targets for which the business identity code is not found seemed to be firms not doing business in Finland or not identified by name clearly enough to match to register data. In the following analysis, the firms having business identity codes form our sample of firms funded by business angels.

In addition to firm counts, the trends in domestic employment, turnover, labor productivity, financial performance and survival are considered in our analysis. Employment and other background information (e.g., firm industry, region and age) are based on the business register of Statistics Finland.

Turnover and other financial statement data are retrieved from the registries of Suomen Asiakastieto Oy, a leading credit-rating company in Finland. In addition, information on public support for research, development and innovation activities is gathered from Business Finland's database.[1] With the exception of business angel and public R&D&I support data, the last available year in the firm-level datasets is 2017, restricting our main period of analysis to the years 2013–2017.

3.1 Age, employment, sales and value added at the time of investment

We start our analysis by considering the basic characteristics of firms that have received business angel investments in the pooled data from the years 2013–2017.[2] We first analyze target firms' age and size in the investment year.

Our analysis shows that the targets of business angel investments are typically young startups. Chart (a) in Figure 3.1 summarizes the proportional distribution of firms' age at the time of investment. Half of the target firms are less than 5 years old, and 75% of them are less than 8 years old. Nevertheless, the overall scale is quite large: the youngest firms in the sample are one year old and the oldest are 64 years old at the time of investment.

Chart (b) in Figure 3.1 depicts the target firms' employment distribution on a percent scale at the time of investment. The target firms are typically very small: the median number of workers is 4–5, and 75% of firms employ fewer than 10 workers. The largest firm in the sample employed 301 workers at the time of investment.

The net sales of target firms are typically very modest at the time of business angel investment (Chart *c* in Figure 3.1). The median of net sales is 100 thousand euros (at the 2010 price level). Three out of four target firms generate net sales of less than 0.5 million euros, and only one firm out of six generates more than one million euros.

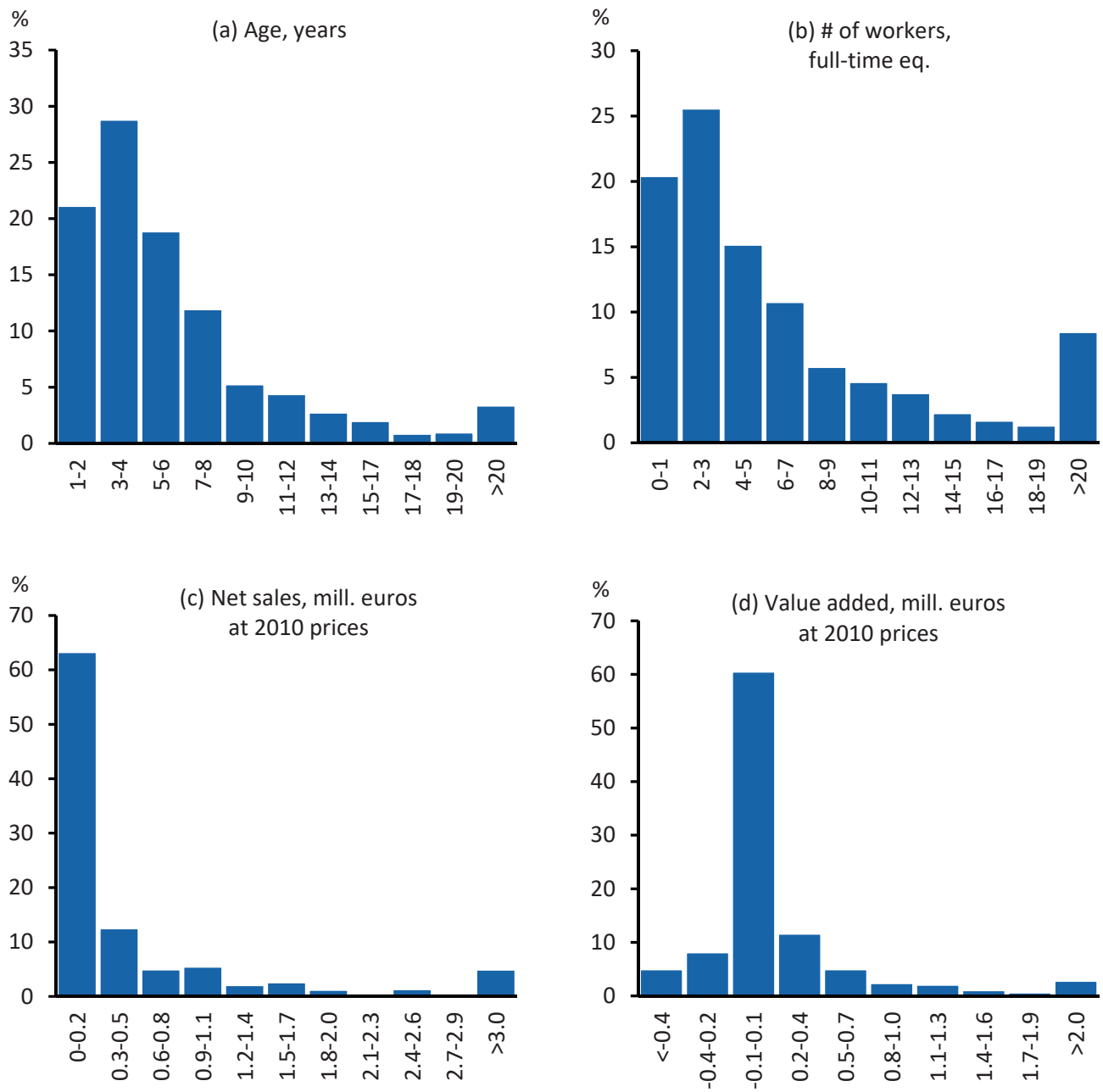
Table 3.1 Business angel datasets and the coverage of business identity codes

Year	The number of investment targets in FiBAN annual statistics	Targets having name/business ID, duplicates dropped	Business ID available or found from official business register	% of business ID found from targets having name/business ID
2013	164	114	101	89 %
2014	238	179	163	91 %
2015	322	221	190	86 %
2016	324	314	263	84 %
2017	273	242	223	92 %
2018	435	408	351	86 %

Data sources: FiBAN, Statistics Finland, Suomen Asiakastieto Oy and the Business Information System BIS ("YTJ" in Finnish).

The value added of the target firms at the time of investment is typically quite close to zero (Chart *d* in Figure 3.1). The median value added calculated over the whole time period in the sample is only 13 thousand euros at the time of investment (at the 2010 price level). The variation is, however, quite large. The lowest 25th percentile of firms generates value added amounting to -59 thousand euros. The highest 25th percentile, in turn, generates at least 184 thousand euros worth of value added, calculated over the whole sample period.

Figure 3.1 The proportional distributions of age, employment, sales and value added of firms that have been funded by business angels in 2013–2017, measured in the investment year (%)



Data sources: FiBAN, Statistics Finland and Suomen Asiakastieto Oy.

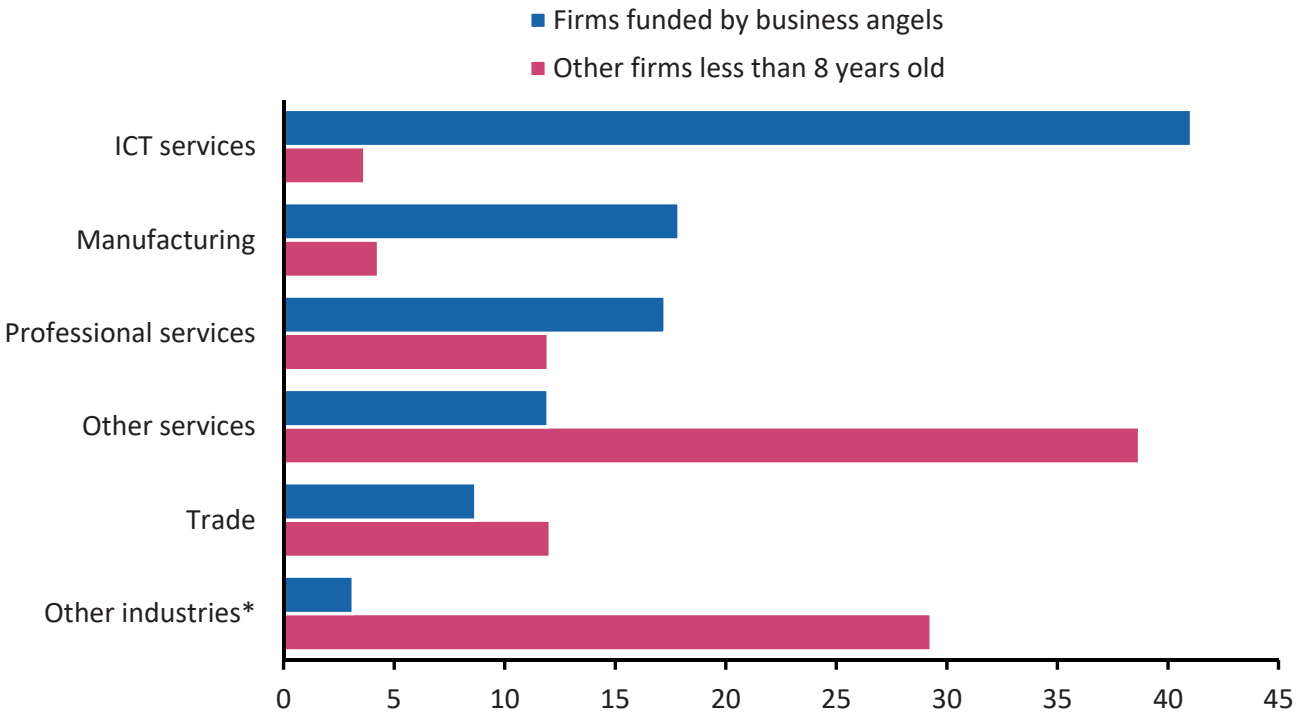
3.2 Industry and regional distributions

Approximately 80% of firms funded by business angels in 2013–2017 operate in the service sector. As many as 41% of target firms provide information and communication technology (ICT) services, and 17% provide professional services such as engineering activities and related technical consultancy (Figure 3.2). Nearly 18% of firms operate in the manufacturing industry. The shares of ICT services and manufacturing have been quite unchanged over the sample years, while the share of professional services has slightly declined (see Table A.1 in the Appendix).

As the great majority of firms funded by business angels are less than 8 years old, we next use this as a threshold to compare the industry distribution to a relevant firm population. As we can see from Figure 3.2, ICT services is a remarkably more significant field of industry among the firms funded by business angels than among other firms under 8 years old. In addition, the shares of manufacturing and professional services are also remarkably higher in the group of firms funded by business angels than among other youngish firms in Finland.

In terms of geographical distribution, 60% of firms funded by business angels in the sample period are in the capital region and other areas in the province of Uusimaa (Table 3.2). The provinces of Pirkanmaa (8%), Varsinais-Suomi (7%) and Pohjois-Pohjanmaa (7%) are the other main geographical locations. These four provinces represent over 80% of geographical locations of business angels' target firms during the years 2013–2017. In each year between 2013 and 2017, the share of Uusimaa Province has been over half. The percentage of Pohjois-Pohjanmaa Province has declined most notably. Additionally, the proportion of Varsinais-Suomi Province has decreased in recent years.[3]

Figure 3.2 The industry distribution (%) of firms that have been funded by business angels in 2013–2017 compared to other firms less than 8 years old in Finland



Data sources: FiBAN and Statistics Finland. *Agriculture, forestry and fishing; Mining and quarrying; Electricity, gas, steam and air conditioning supply; Water supply; sewerage, waste management and remediation activities; Construction.

Table 3.2 The regional distribution (%) by province of firms that have been funded by business angels in 2013–2017 compared to other less than 8-year-old firms in Finland

Region	(a) Firms funded by business angels	(b) Other firms less than 8 years old	(c) Difference (a–b)
Uusimaa	60.8	33.3	27.5
Pirkanmaa	8.3	9.0	-0.7
Varsinais-Suomi	7.4	8.8	-1.4
Pohjois-Pohjanmaa	6.9	6.4	0.5
Keski-Suomi	2.8	4.9	-2.1
Kanta-Häme	2.3	2.9	-0.6
Satakunta	1.9	3.7	-1.8
Pohjois-Savo	1.9	4.1	-2.2
Päijät-Häme	1.8	3.2	-1.5
Pohjois-Karjala	1.3	2.7	-1.4
Pohjanmaa	1.3	3.1	-1.8
Etelä-Karjala	0.8	2.3	-1.5
Etelä-Savo	0.6	3.0	-2.4
Lappi	0.5	3.0	-2.5
Ahvenanmaa	0.5	0.7	-0.2
Etelä-Pohjanmaa	0.4	3.8	-3.4
Kymenlaakso	0.3	2.7	-2.4
Kainuu	0.3	1.3	-1.0
Keski-Pohjanmaa	0.1	1.2	-1.1

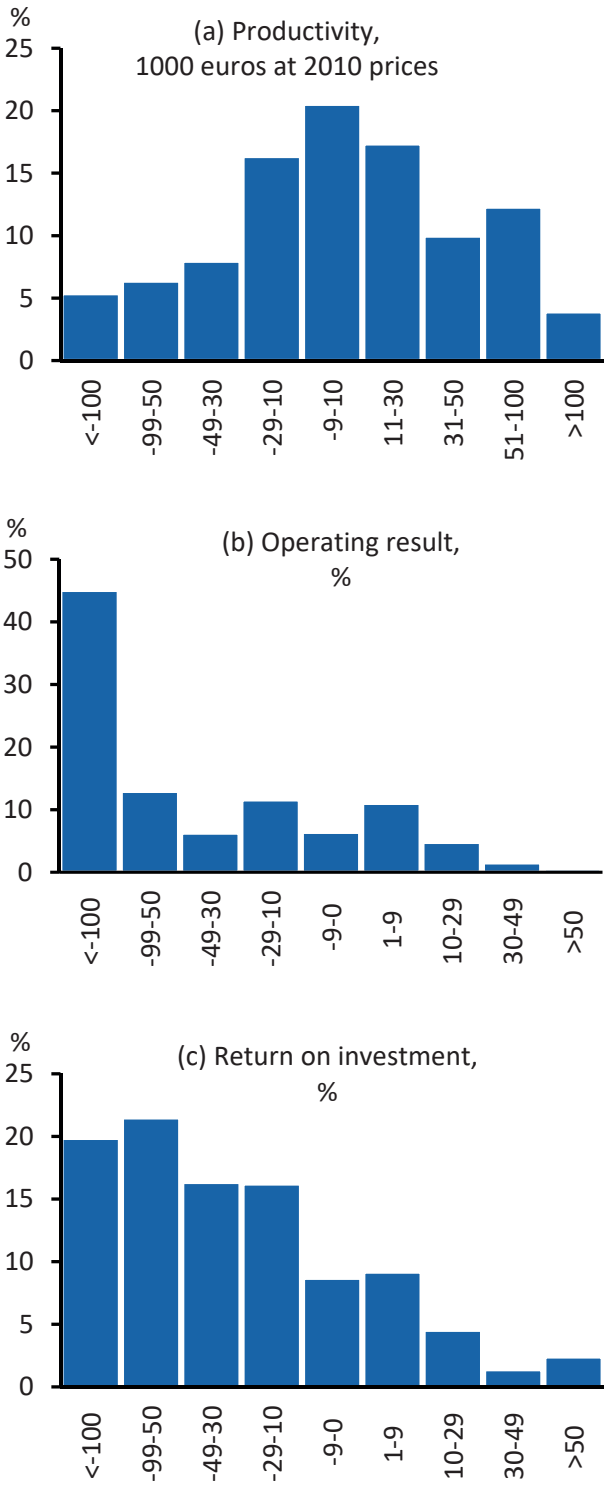
Data sources: FiBAN and Statistics Finland.

Compared to other youngish firms in Finland, the percentage of the province of Uusimaa is clearly higher among firms funded by business angels (Table 3.2). Except for the provinces of Uusimaa and Pohjois-Pohjanmaa, in all other provinces, the share of firms funded by business angels is lower than in the regional distribution of youngish firms in Finland (Column *c* in Table 3.2).

3.3 Financial performance and growth

Regarding financial performance, we first consider the proportional distribution of target firms' labor productivity (value added per worker) in the year of angel investment (Chart *a* in Figure 3.3).[4] As most of the target firms are startups, it is not surprising that, on average,

Figure 3.3 The proportional distributions of productivity and profitability of firms that have been funded by business angels in 2013–2017 measured in the investment year (%)



Data sources: FiBAN, Statistics Finland and Suomen Asiakastieto Oy.

the productivity level is very low. Median productivity over the sample years is only 5 thousand euros at the 2010 price level. However, the range of distribution is quite large: the lowest 25th percentile of firms has a negative productivity level amounting to -19 thousand euros, and the highest 25th percentile of firms has a positive productivity level amounting to 32 thousand euros. Forty-five percent of firms generate negative value added in the investment year.

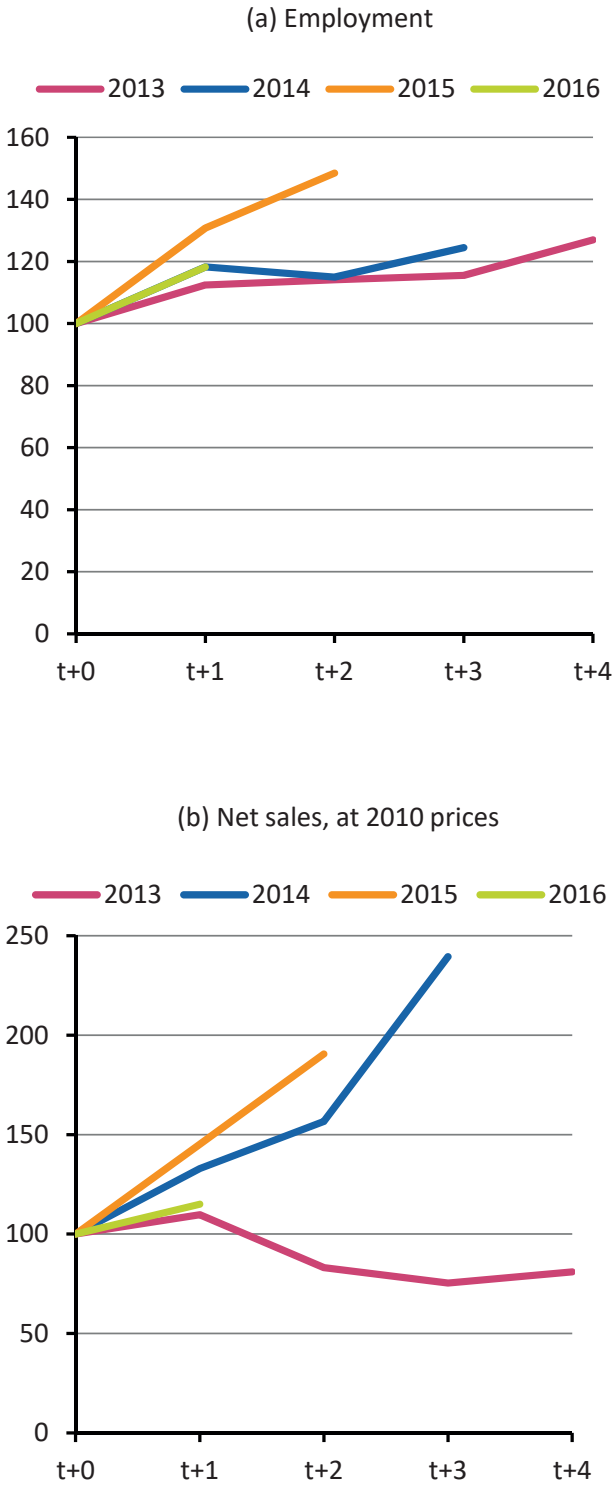
Most of the firms funded by business angels make an operating loss in the investment year (Chart *b* in Figure 3.3). Even the highest 25th percentile of firms has a negative operating result in relation to net sales (-11%). The median of the ratio of operating result to net sales over the sample years is -79%, indicating that operating costs are in this case nearly twice as large as net sales. These negative operating results explain at least partly the low productivity levels.

As Chart (c) in Figure 3.3 shows, target firms are also typically unprofitable in the investment year in terms of return on investment (ROI). The median ROI over the years is -37%, and even in the highest 25th percentile, the corresponding value is highly negative (-9%). In all, over 80% of firms have a negative ROI in the year of investment.

Next, we explore the development of firms funded by business angels after the investment year. Figure 3.4 illustrates the trends of total employment and sales growth by business angels' target firm vintages (Chart *a* in Figure 3.4). We can see that in all vintages, the firms have been recruiting workers and thus investing in human capital. Depending on vintage, the sum of employment of target firms two years after the investment year is 14–48% higher than in the investment year and 16–24% higher after three years.

In the case of net sales, the trend is also upwards, except for the vintage 2013, in which the sum of net sales increases after the first year of investment but then decreases in the two following years and again increases in the last year of observation (Chart *b* in Figure 3.4). In the 2014 and 2015 vintages, the sums of net sales are 57% and 91% higher, respectively, after two years than in the investment year and 139% higher after three years in the 2014 vintage, i.e., the sum of firms' net sales more than doubled in three years.

Figure 3.4 The growth of total employment and sales by vintage of business angels' target firms (index=100 in the year that a firm receives business angel investment)



Data sources: FiBAN, Statistics Finland and Suomen Asiakastieto Oy.

4 Impacts of business angel investing

4.1 Target firms vs. matched similar kinds of firms

It is interesting to analyze how firms that have received funding from business angels have performed compared to similar kinds of firms that have not received that funding. However, the causal effects of angel funding are complicated to study because one cannot observe the alternative state of the world. We analyze the differences between angel-backed firms and matched control firms and the interaction between angel funding and public innovation funding.

To study these effects, we follow a three-step procedure. First, for each vintage of firms funded by business angels, we search for an equal number of nonfunded firms from Statistics Finland's business register by using the coarsened exact matching (CEM) statistical method (Iacus, King, & Porro, 2011; 2012).[5] The matching criteria are firm age (0–4, 5–9, 10–14, 15–19, 20+ years), size (0–4, 5–9, 10–19, 20–49, 50–99, 100–249, 250+ workers) and industry (25 two-digit-level industry codes). Second, we calculate for each firm the difference of the outcome variable (e.g., employment) with respect to the "treatment" year to form a dependent variable. Finally, we run ordinary least squares (OLS) estimations using robust standard errors. The dependent variable in each estimation is the above defined difference, and explanatory variables include the indicator variable for business angel investment and indicator variables controlling for "treatment" years.

Figure 4.1 depicts the results of the analysis. Each chart shows point estimates of the differences and the 95% confidence intervals. The results can be interpreted such that if the point estimate is positive (*negative*) and the lower (*upper*) bound of the confidence interval is also positive (*negative*), then the difference is statistically significant.

Regarding the growth of employment, firms funded by business angels performed better than the control group one to three years after the investment. The point estimate of the difference is still positive four years after the investment, but due to the large deviation, it is not statistically significant.

In terms of net sales, the point estimate of the difference is positive at all observation points, but it is statistically significant only at four years after the investment. In the cases of value added and productivity, the differences between firms funded by business angels and the control group are not statistically significant.

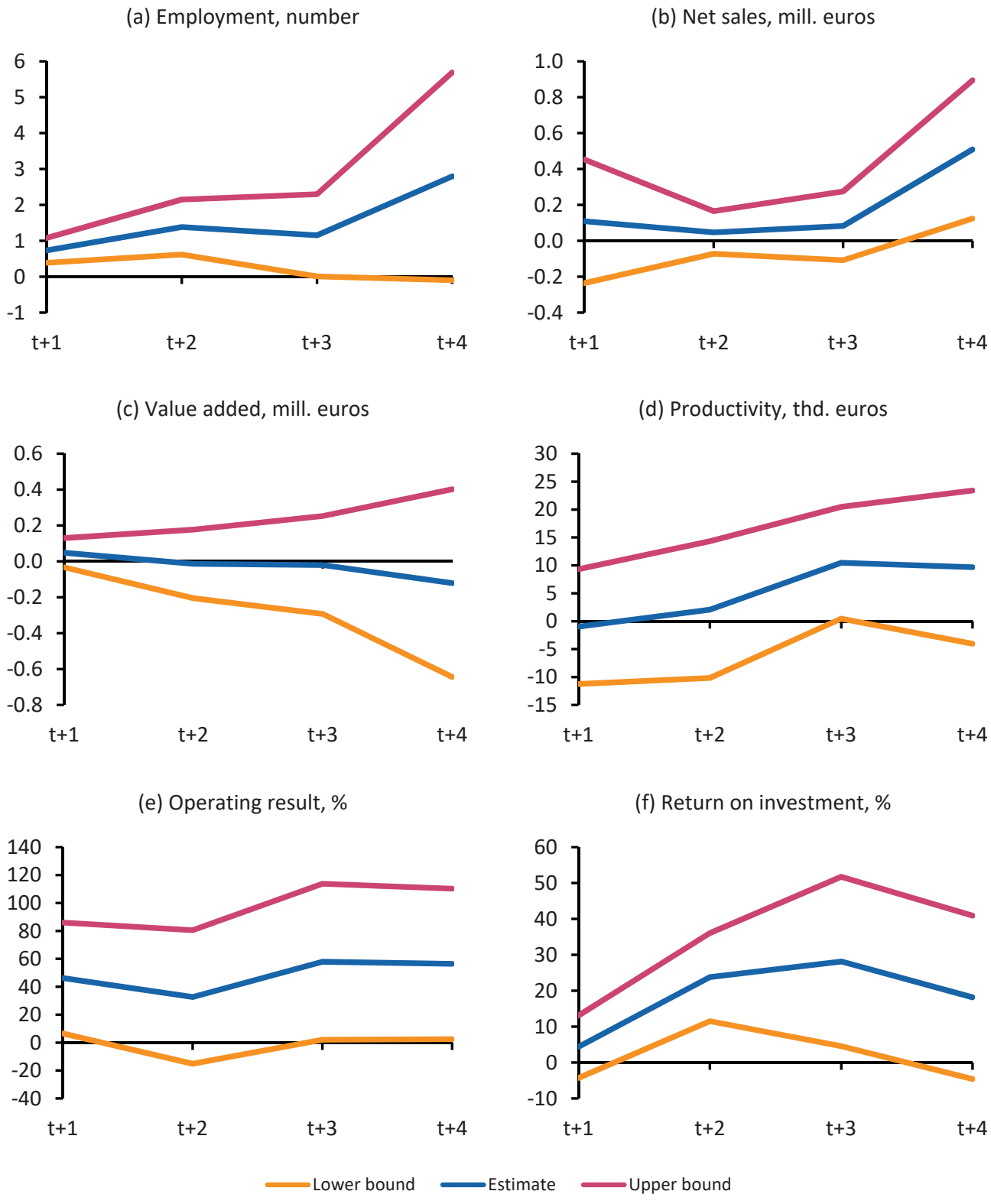
In addition, the results hint that firms backed by business angels have managed to improve their financial performance more than the firms in the control group. The point estimates of the differences in both operating margin (the ratio of operating result to net sales) and return on investment are positive at all observation points and statistically significant in the case of operating margin in three out of four observation points and in the case of return on investment at two out of four observation points.

To obtain more insight into the growth patterns of firms funded by business angels, we calculated three years' proportional changes in employment and net sales in the treated and matched firms' groups. Due to data restrictions, we can carry out these calculations only regarding vintages 2013 and 2014.

Figure 4.2 summarizes the results. The findings indicate that the growth distribution for firms funded by business angels is more widely dispersed, i.e., there are both more successful and unsuccessful cases, than for the control group. This is a similar kind of finding to the case of Finnish private equity investments studied by Pajarinen et al. (2016). In addition, the results hint that the "hunger for growth" is more typical in the firms in which business angels are involved: we can observe that in the control group, the changes in both employment and net sales are more concentrated to quite modest percentages (±9%) than in the firms funded by business angels. In addition, large positive changes (>50%) are more typical in firms funded by business angels.

In addition to a capital stimulus and a push for growth, the involvement of business angels in target firms may increase knowledge of how to successfully manage business operations. This, in turn, may improve the likelihood that firms survive longer in business. In Figure 4.3, we draw the survival distributions of each vintage of busi-

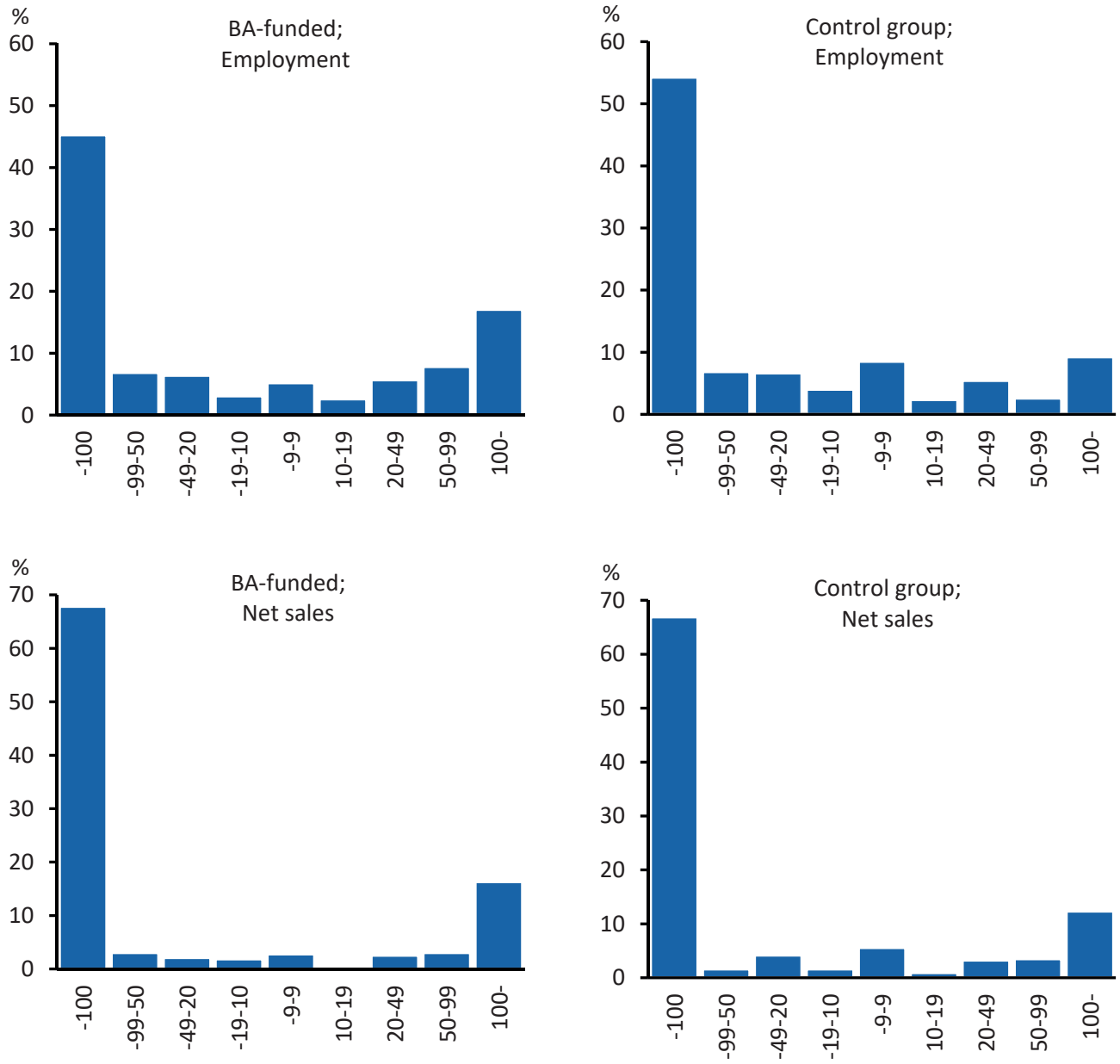
Figure 4.1 **The development of firms that have been funded by business angels in 2013–2016 in relation to matched firms. Reported values are point estimates of the differences and their 95% confidence intervals**



Data sources: FiBAN, Statistics Finland and Suomen Asiakastieto Oy.

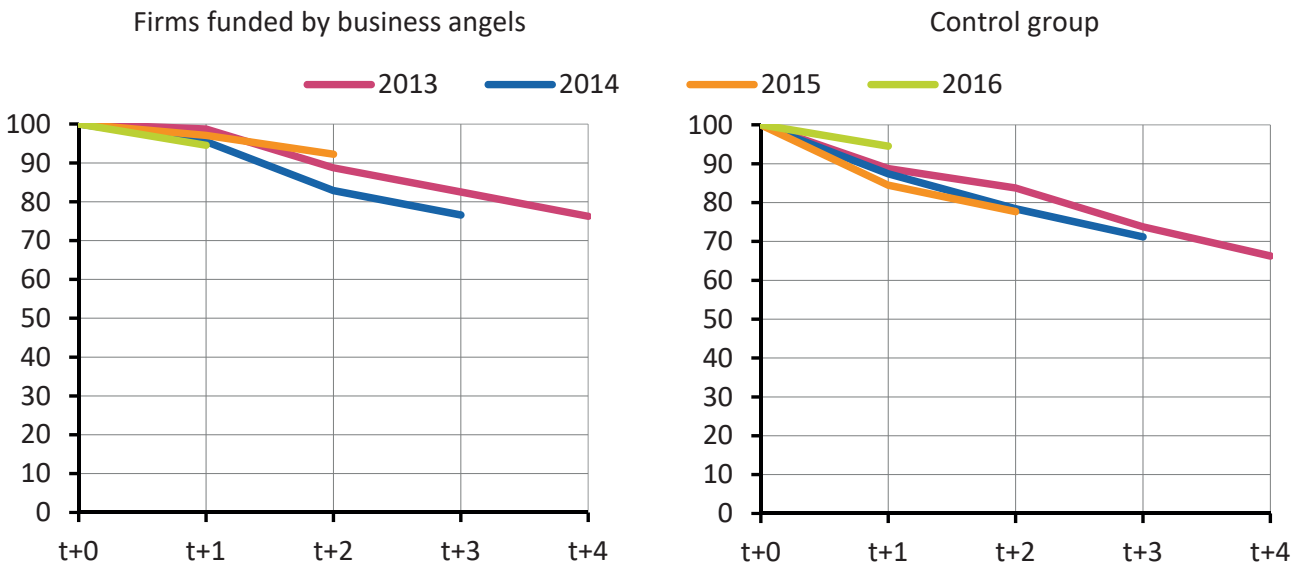
ness angel–funded firms (left) and corresponding survival rates in the control group (right). It seems that receiving business angel funding indeed increases the probability of survival. After two years, 83–93% of firms funded by business angels are still doing business, and after three years, the percentage is in the range of 77–83%. In the control group, the corresponding ranges of percentages are 78–84% (after two years) and 71–74% (after three years).

Figure 4.2 The proportional distribution of three years' change of employment and net sales (at 2010 prices) in firms funded by business angels and matched firms in the 2013 and 2014 vintages



Notes: BA-funded = firms funded by business angels in 2013–2014, control group = firms matched by the CEM method.
Data sources: FiBAN, Statistics Finland and Suomen Asiakastieto Oy.

Figure 4.3 The percentage of surviving firms by vintage



Data sources: FiBAN and Statistics Finland.

4.2 Interaction between business angels and public R&D&I support

As we notice from the industry distribution of angel-funded firms, the large share of these firms operates in technology- and knowledge-oriented industries such as ICT and professional services. In addition, angel-backed firms are more likely than other early-stage firms to produce some physical product. This kind of distribution of industries implies that many firms funded by business angels are probably involved in R&D activities. In our data, we do not directly observe how many of the firms have research, development and innovation activities. Instead, we have Business Finland's data on public R&D&I support.

Our analysis reveals that receiving public R&D&I support is very common among the firms funded by business angels (Table 4.1).

Table 4.1 The percentage of firms funded by business angels that have also received public R&D&I support (minimum EUR 30000) in some years (%)

Year	Public R&D&I support at least once in 2000–2018	Public R&D&I support prior to business angel investment	Public R&D&I support and business angel investment in the same year	Public R&D&I support after business angel investment
2013	72	51	41	48
2014	69	51	35	44
2015	75	57	31	46
2016	77	57	37	41
2017	79	66	38	34
2013–2017	75	57	36	42
2018	66	57	30	–

Data sources: Business Finland and FiBAN.

Calculated over the total sample of firms in 2013–2017 (Table 4.1), as many as 75% of the firms received public R&D&I funding at least once during their life span.[6] Furthermore, it is somewhat more probable that firms received public R&D&I support prior to business angel investments. This finding suggests that receiving public R&D&I support may have a sort of screening effect when business angels search for potential targets for their investments.

Next, we analyze the interactions of business angel (**BA**) funding and public R&D&I support (**BF**) by focusing on the following subsample of firms.[7] *First*, we include firms operating in manufacturing, ICT services and professional services in the analysis. These three industries consist of 75% of all investment targets of business angels, and their proportion of public R&D&I support is not negligible either. *Second*, as 75% of target firms of business angel funding are less than 8 years old, we use this as an upper bound of firms' age in the treatment year. *Third*, we exclude large firms in the treatment year from the sample. We utilize the criteria for firms' size set by the European Commission. According to this definition, small firms are independent firms having fewer than 50 workers and net sales or total assets of less than 10 million euros.[8] *Fourth*, we concentrate on the population of firms in 2013–2014 to study the effects of treatment 1–3 years after the treatment year.

In total, we have 34628 firms in the sample, of which, in the 2013–2014 period, 39 (0,1%) have obtained only business angel funding, 722 (2,1%) only public R&D&I support and 83 (0,2%) both business angel funding and public R&D&I support.

Table 4.2 illustrates the status of the sample firms in two periods after 2013–2014: Panel A reports the status in 2015–2016, and Panel B reports the status in 2015–2018. The frequencies in Table 4.1 show that there is quite high probability of continuous treatment in both business angel funding and public R&D&I support. Furthermore, it seems that firms treated both by BAs and BF are the most likely to obtain some treatment in the following period. The results suggest, moreover, that the treatment of BF seems to be more continuous than the funding by BAs.

Next, we analyze the development of sample firms after treatment in terms of growth of employment, net sales, value added and productivity one to three years after the

Table 4.2 Transition table of sample firms (%)

		T={2015–2016}			
T={2013–2014}	No treatment	Only BA	Only BF	Both BA and BF	
Panel A					
No treatment	99.01	0.04	0.91	0.04	100
Only BA	66.67	25.64	2.56	5.13	100
Only BF	59.14	2.49	32.41	5.96	100
Both BA and BF	21.69	21.69	30.12	26.51	100

		T={2015–2018}			
T={2013–2014}	No treatment	Only BA	Only BF	Both BA and BF	
Panel B					
No treatment	98.48	0.08	1.36	0.08	100
Only BA	56.41	30.77	5.13	7.69	100
Only BF	49.72	2.35	38.50	9.42	100
Both BA and BF	19.28	15.66	26.51	38.55	100

Notes: BA = a firm has received business angel funding, BF = a firm has received Business Finland funding.
Data sources: Business Finland, FiBAN and Statistics Finland.

treatment of business angel and/or public R&D&I support. The basic criteria to be included in the sample are the same as in the transition table analysis above. We define the following:

- BA_treated: gets value 1 if a firm has received business angel funding in 2013–2014, and 0 otherwise;
- BF_treated: gets value 1 if a firm has received public R&D&I support in 2013–2014, and 0 otherwise;
- BAxBF: gets value 1 if a firm has received both business angel funding and public R&D&I support in 2013–2014, and 0 otherwise.

From the control group, we exclude all firms that received either business angel funding or public R&D&I support in the period of analysis. In the first stage of the analysis, we carry out one-to-one CEM matching in which the treatment is that a firm has received either business angel funding or public R&D&I support in 2013–2014.[9] In the second stage, we perform OLS regressions in the matched sample to study correlations with growth in absolute terms at t+1, t+2 and t+3.[10]

Tables 4.3–4.6 summarize the findings of the analysis. These results suggest that in the estimation sample, receiving public R&D&I support correlates positively with both growth of employment and net sales in all time periods studied (Tables 4.3 and 4.4). In addition, receiving business angel funding has a positive correlation with employment growth one year after treatment; no statistically significant correlation is found in terms of net sales development. Regarding the growth of value added, the only statistically significant correlation coefficient is BF_treated at t+2 (Table 4.5).

From Table 4.6, we can observe that statistically significant correlations with the growth of labor productivity are found three years after the treatment. It seems that both receiving business angel funding and public R&D&I support have positive correlation coefficients. However, the interaction term is negative. Summing the coefficients implies that at t+3, the total correlation between public R&D&I support and productivity growth is negative, and the total correlation between business angel funding and productivity growth is positive but close to zero. One possible explanation for the negative interaction term could be that firms receiving both business angel funding and public R&D&I support could be ones that carry out longer-term technology development. These firms may have continued to recruit experts and

Table 4.3 Partial correlations with growth of employment (# of workers)

	T+1 Coef./S.E.	T+2 Coef./S.E.	T+3 Coef./S.E.
BA_treated	0.162	0.653	-0.027
	(0.359)	(0.618)	(1.182)
BF_treated	0.663***	1.088***	1.542***
	(0.103)	(0.169)	(0.231)
BAxBF	0.684	0.048	0.621
	(0.481)	(0.784)	(1.359)
Wald tests, H0:			
BA_treated and BAxBF jointly 0	3.504**	1.603	0.390
BF_treated and BAxBF jointly 0	25.003***	21.810***	23.537***
BA_treated = BF_treated	1.896	0.483	1.736
R2 adjusted	0.048	0.051	0.052
Wald(Model)	2.994***	2.744***	3.043***
Observations	1547	1457	1358

Notes: Robust standard errors in the parentheses. Statistical significance: * p<0.10, ** p<0.05, *** p<0.01. Other control variables included in the regressions are size groups (0–4, 5–9, 10–19, 20–49 workers), firm age, industry indicators and treatment year indicators.

Data sources: Business Finland, FiBAN, Statistics Finland and Suomen Asiakastieto Oy.

Table 4.4 Partial correlations with growth of net sales (mill. euros at 2010 prices)

	T+1 Coef./S.E.	T+2 Coef./S.E.	T+3 Coef./S.E.
BA_treated	-0.013	-0.022	0.060
	(0.026)	(0.089)	(0.142)
BF_treated	0.062 ***	0.125 ***	0.129 ***
	(0.015)	(0.031)	(0.037)
BAxBF	0.011	0.071	0.003
	(0.038)	(0.109)	(0.165)
Wald tests, H0:			
BA_treated and BAxBF jointly 0	0.128	0.319	0.375
BF_treated and BAxBF jointly 0	10.468 ***	9.753 ***	6.381 ***
BA_treated = BF_treated	8.165 ***	2.610	0.229
R2 adjusted	0.050	0.036	0.056
Wald(Model)	2.624 ***	15.916 ***	2.709 ***
Observations	1558	1481	1378

Notes: Robust standard errors in the parentheses. Statistical significance: * p<0.10, ** p<0.05, *** p<0.01. Other control variables included in the regressions are size groups (0–4, 5–9, 10–19, 20–49 workers), firm age, industry indicators and treatment year indicators.

Data sources: Business Finland, FiBAN, Statistics Finland and Suomen Asiakastieto Oy.

Table 4.5 Partial correlations with growth of value added (mill. euros at 2010 prices)

	T+1 Coef./S.E.	T+2 Coef./S.E.	T+3 Coef./S.E.
BA_treated	-0.052	0.050	0.095
	(0.035)	(0.052)	(0.080)
BF_treated	0.009	0.028 *	0.041
	(0.010)	(0.015)	(0.026)
BAxBF	0.057	-0.050	-0.062
	(0.042)	(0.069)	(0.110)
Wald tests, H0:			
BA_treated and BAxBF jointly 0	1.141	0.461	0.798
BF_treated and BAxBF jointly 0	1.724	1.790	1.274
BA_treated = BF_treated	2.987 *	0.168	0.449
R2 adjusted	0.030	0.020	0.044
Wald(Model)	4.536 ***	1.866 ***	2.636 ***
Observations	1220	1119	1057

Notes: Robust standard errors in the parentheses. Statistical significance: * p<0.10, ** p<0.05, *** p<0.01. Other control variables included in the regressions are size groups (0–4, 5–9, 10–19, 20–49 workers), firm age, industry indicators and treatment year indicators.

Data sources: Business Finland, FiBAN, Statistics Finland and Suomen Asiakastieto Oy.

Table 4.6 Partial correlations with the growth of productivity (thd. euros at 2010 prices)

	T+1 Coef./S.E.	T+2 Coef./S.E.	T+3 Coef./S.E.
BA_treated	-8.696	12.530	30.757**
	(9.132)	(7.731)	(13.436)
BF_treated	2.822	3.901	10.574**
	(2.502)	(2.406)	(4.268)
BAxBF	12.941	-11.256	-30.298*
	(10.939)	(9.800)	(17.224)
Wald tests, H0:			
BA_treated and BAxBF jointly 0	0.702	1.332	2.621*
BF_treated and BAxBF jointly 0	1.683	1.597	3.776**
BA_treated = BF_treated	1.549	1.233	2.245
R2 adjusted	0.027	0.001	0.023
Wald(Model)	2.659***	3.838***	1.834***
Observations	1233	1121	1069

Notes: Robust standard errors in the parentheses. Statistical significance: * p<0.10, ** p<0.05, *** p<0.01. Other control variables included in the regressions are size groups (0–4, 5–9, 10–19, 20–49 workers), firm age, industry indicators and treatment year indicators.

Data sources: Business Finland, FiBAN, Statistics Finland and Suomen Asiakastieto Oy.

other workers after the observed treatment period, increasing labor input disproportionately to value added and leading to a negative impact on labor productivity. Apart from the correlation with productivity, we find no statistically significant interaction coefficients in the regressions.

5 Conclusions

What kinds of firms receive angel funding?

Our results show that in Finland, business angels invest annually in a few hundred mainly startup firms that operate typically in knowledge-intensive industries. In addition, angel-backed target firms are more likely to produce physical goods than other startups. Another difference concerns the location of angel-backed firms. Approximately 60% of firms funded by business angels are in the capital region and other areas of the province of Uusimaa, while only one-third of all youngish firms are in that province. This observation might be explained by the location of business angels themselves. However, our data do not enable us to validate this explanation.

In our data, angel-backed firms are typically young and small firms. Measured in the investment year, their median age ranges between 4 and 5 years, and 75% of them are less than 8 years old. Three-fourths of these firms employ fewer than 10 employees and generate net sales of less than half million euros. Most of the firms funded by business angels make an operating loss in the investment year.

Angel-funded firms compared to other firms

We compare angel-funded firms to nonfunded control firms that were as similar as possible in characteristics in terms of industry, age and size. When focusing on angel investments alone – covering the full sample of firms but not controlling for the effect of receiving public R&D&I funding – the findings suggest that the angel-funded firms perform better in terms of employment and short-term profitability than the nonfunded control firms.

The findings also indicate that the growth distribution of firms funded by business angels is more widely dispersed than among nonfunded firms. That is, among angel-backed firms, there are both more successful and unsuccessful cases than in the comparison group.

Moreover, we compare the survival rate of angel-funded and other firms. The results suggest that receiving angel funding increases the probability of survival in business. After 2 years, 83–93% of angel-backed firms continued their operations, while in the comparison group, the corresponding share was 78–84%. Hence, firms that have received business angel funding seem more likely to survive in business than their counterparts.

The interaction between angel funding and public R&D&I funding

Our findings show that receiving public R&D&I funding is very common among firms funded by business angels. As many as 75% of these firms received public R&D&I funding during their lifespan. During 2013–2017, 57% of angel-backed firms received public R&D&I funding before they obtained angel funding, while 42% of them received public R&D&I funding after they obtained angel financing.

Finally, to deepen our analysis, we restrict the estimation sample to consist of small early-stage firms operating in knowledge-intensive services or manufacturing. In this kind of sample, business angels' activities are also the most likely to occur. According to our results, receiving public R&D&I funding correlates positively with the growth of employment and net sales in the next three years. Nonetheless, we find very limited evidence concerning the relationship between angel funding and growth in this more restricted estimation sample. There exist faster employment growth rates among the firms that have received angel funding compared to matched control firms, but the average growth rates do not significantly differ when we control for receiving public R&D&I funding and other background characteristics. Furthermore, our estimation results do not suggest that receiving both business angel funding and public R&D&I funding would correlate statistically significantly with the growth of employment or net sales.

An avenue for future research

Future work regarding the subject of this report should extend the analysis in several dimensions. The impact analysis of business angel funding could utilize more sophisticated statistical methods than we have used in the study. The performance differences between angel-backed and other firms may be driven by unobserved differences between these two groups that remain difficult to control for. In addition, angel funding represents only one type of equity funding, and our control group could possibly include, for instance, venture capital -backed firms. The data covering both angel and venture capital funding would allow us to find better control groups, and it would also enable the analysis of the interaction between angel and venture capital funding. Finally, due to data limitations, we are able to consider, at best, the development of angel-backed firms in the next three years after angel funding. This period is rather short compared to business angels' typical investment horizon. Thus, our results are potentially driven by a relatively small sample size and a short posttreatment observation period. When more data accumulate, future studies could analyze the impact of angel investments in the longer run.

Endnotes

1 We study Business Finland's grants and loans for firms' research, development and growth purposes. In the dataset, the main types of this finance include direct R&D support, *de minimis* finance and funding for young innovative companies.

2 In the Appendix, we report the distributions of age, employment, sales and value added by vintage in Figure A.1.

3 See Figure A.2 in the Appendix for details.

4 We report in the Appendix the distributions of financial performance variables by vintage in Figure A.3.

5 If a firm funded by business angels appears in more than one vintage, i.e., it has received funding in several years, we have kept only the earliest occurrence.

6 We use 30000 euros as a lower bound threshold value since smaller subsidies are, by and large, used for the planning and feasibility studies of R&D projects and do not represent actual R&D subsidies.

7 We define "treatment" in this section as receiving either business angel funding or public R&D&I support or both.

8 https://ec.europa.eu/growth/smes/business-friendly-environment/sme-definition_en

9 The matching criteria have been employment (0–4, 5–9, 10–19, 20–50 workers), firm age (0–4, 5–8 years) and 2-digit level industry indicators.

10 The number of firms in each treatment group is shown in tables A.2–A.4 in the Appendix.

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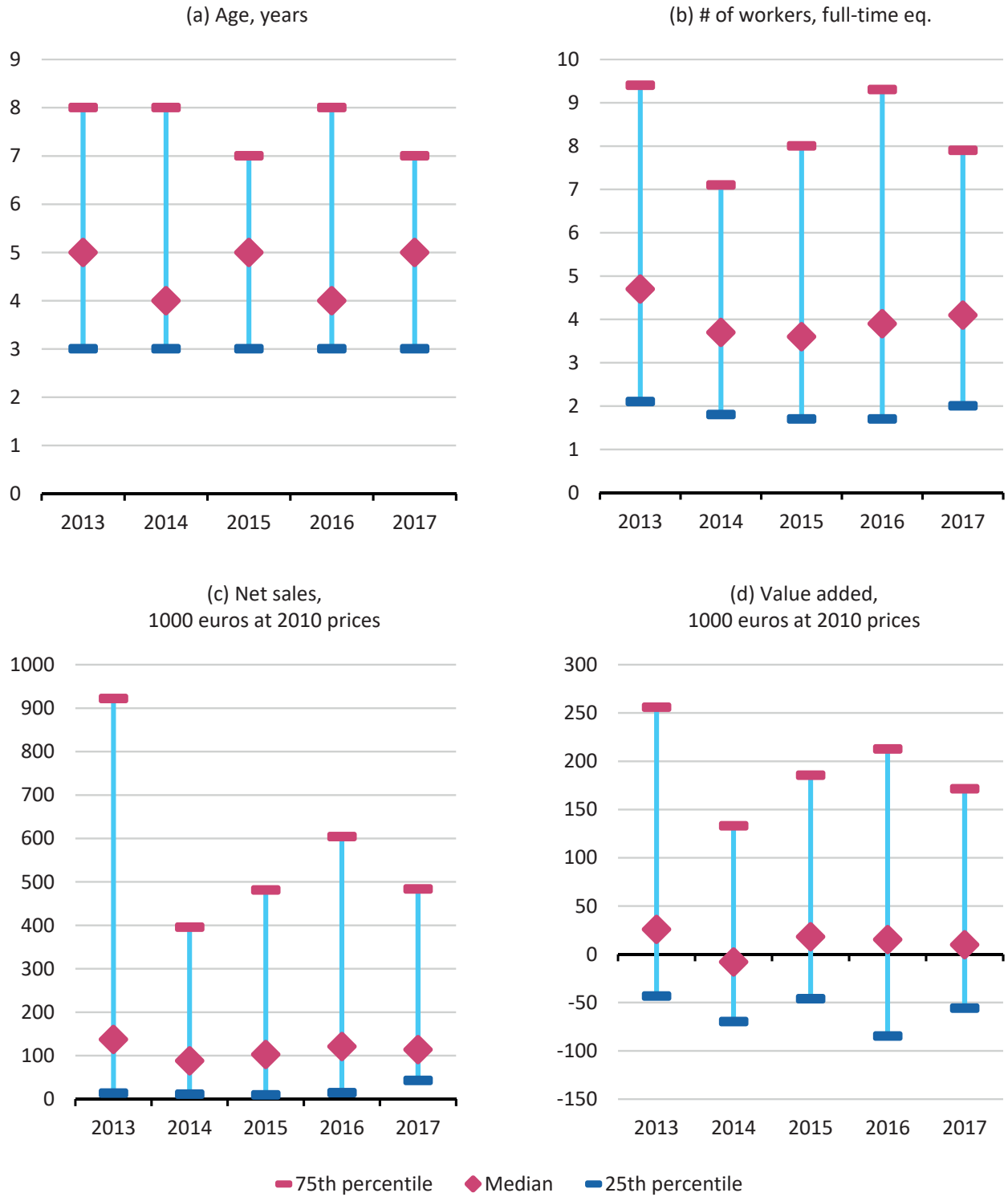
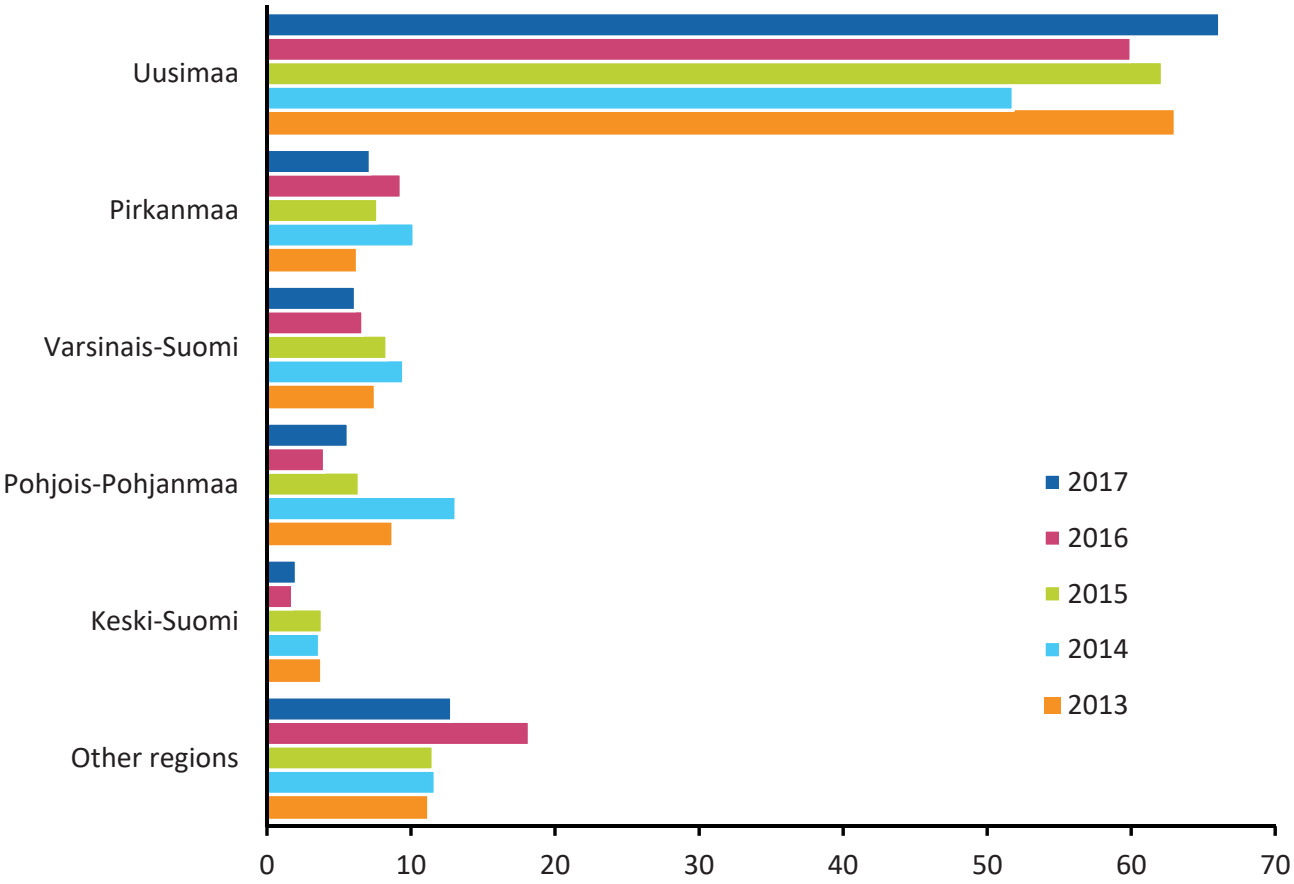
Appendix

Figure A.1 **The distributions of age, employment, sales and value added of firms that have been funded by business angels in 2013–2017, measured in the investment year**



Data sources: FiBAN, Statistics Finland and Suomen Asiakastieto Oy.

Figure A.2 The regional distribution ("Maakunnat" in Finnish, %) of firms that have been funded by business angels in 2013–2017, 5 most significant provinces distinguished



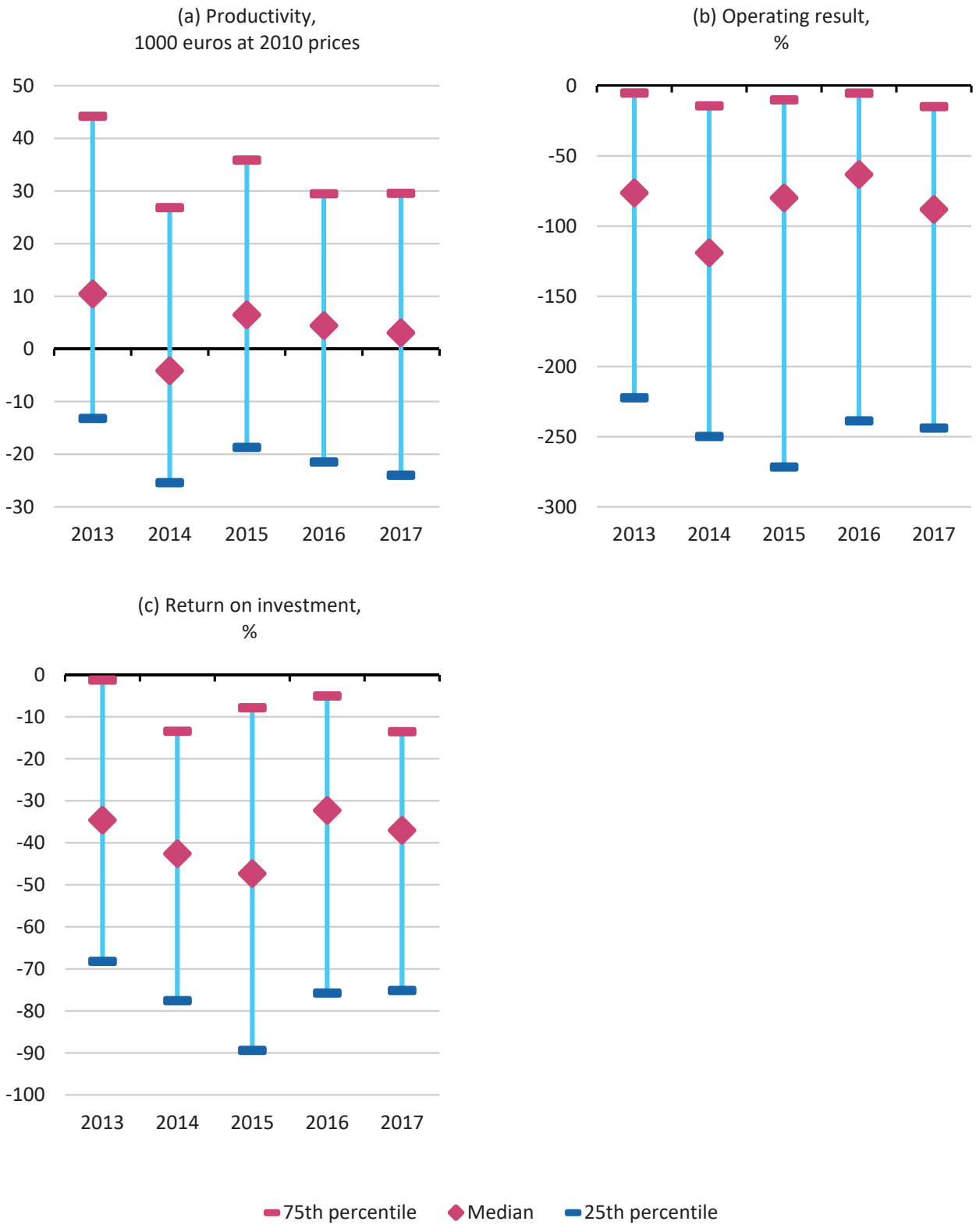
Data sources: FiBAN and Statistics Finland.

Table A.1 The industry distribution (%) of firms that have been funded by business angels in 2013–2017

	(a) ICT services	(b) Professional services	(c) Other services	(d) Trade	(e) Manufacturing	(f) Other industries*
2013	39.5	21.0	9.9	9.9	18.5	1.2
2014	40.2	21.2	11.0	8.0	17.5	2.2
2015	43.0	16.0	9.6	8.3	18.6	4.5
2016	41.3	14.2	14.2	9.8	17.8	2.7
2017	40.5	17.4	12.8	7.7	17.4	4.1

Data sources: FiBAN and Statistics Finland. *Agriculture, forestry and fishing; Mining and quarrying; Electricity, gas, steam and air conditioning supply; Water supply; sewerage, waste management and remediation activities; Construction.

Figure A.3 Financial performance of firms that have been funded by business angels in 2013_2017, measured in the investment year



Data sources: FiBAN, Statistics Finland and Suomen Asiakastieto Oy.

Table A.2 Sample firms in employment estimation (number of firms)

	T+1	T+2	T+3
BA_treated	108	97	80
BF_treated	734	686	644
BAxBF	75	68	58
Non-treated	780	742	692

Data sources: Business Finland, FiBAN, Statistics Finland and Suomen Asiakastieto Oy.

Table A.3 Sample firms in net sales estimation (number of firms)

	T+1	T+2	T+3
BA_treated	110	104	89
BF_treated	745	712	659
BAxBF	75	73	66
Non-treated	778	738	696

Data sources: Business Finland, FiBAN, Statistics Finland and Suomen Asiakastieto Oy.

Table A.4 Sample firms in productivity estimation (number of firms)

	T+1	T+2	T+3
BA_treated	95	78	69
BF_treated	586	539	518
BAxBF	66	57	53
Non-treated	618	561	535

Data sources: Business Finland, FiBAN, Statistics Finland and Suomen Asiakastieto Oy.

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