



Stairway to heaven? rethinking angel investment policy and practice

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ABSTRACT

Angel investing has grown globally across economies, accompanied by growth in both academic and policymaking interest. In this paper, we critically analyse the current state of knowledge about the process and impact of angel investment. We use a series of stylised facts to highlight key trends as well as misperceptions about those trends. These include the rise of formal and ad hoc angel groups, the efficiency of early stage risk capital markets, the complex interaction between angel and institutional venture capital, and policymaking to address perceived capital market failures. We review the emerging literature on angel investment returns and draw on a new simulation-based analysis of tax incentives to challenge the rationale for government intervention in angel investing.

1. Introduction

Notwithstanding the absence of comprehensive, robust and reliable data (Cumming and Johan, 2017), research on angel investing has developed significantly since the early 1980s (Drover et al., 2017; Edelman et al., 2017; Wallmeroth et al., 2018; White and Dumay 2017). Furthermore, the angel market itself continues to evolve; becoming more institutionalised as angel groups gain prominence (Mason et al., 2019). Beyond altruism and the desire to support the entrepreneurial economy, the rationale for angel investment is that the investor will secure above market risk adjusted returns on their investment in the form of capital gains over the medium to longer term (Harrison et al., 2016).

There has been considerable policy interest in developing initiatives to stimulate and grow the angel investment market (Mason, 2009; Carpentier and Suret, 2016). Government intervention has been justified on the basis that it addresses market inefficiencies and coordination failures that restrict access to finance by new high-growth potential ventures (Murray, 2007). In so doing, it helps realise the economic contribution of these ventures through tax incentives which rebalances the investor's risk-reward profile to encourage more investment.

The fundamental rationale for angel investing, from both investor and government perspectives, is predicated on the generation of positive returns, yet despite recent contributions this remains a significantly under-researched area (Gregson et al., 2017). Further, the market failure argument remains weak. To the extent that market failures exist, in principle, there is a role for public policy (Boadway and Tremblay, 2005), given that the early stage risk capital market is characterized by high levels of uncertainty, information asymmetry and agency costs with the potential for superior market returns. Understanding more clearly the distortionary effects of market failure

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Table 1
Stylised facts about angel investing.

Stylised fact	Conventional wisdom	Challenges and corrections
Available capital	As or more important as VC in early stage funding (Sohl, 2003; Mason and Harrison, 2000; Goldfarb et al 2009; OECD, 2011) Widely distributed nationally and internationally (Harrison 2017; Cumming and Zhang 2019)- ‘angels live everywhere’ (Gaston, 1990, 273) More broadly based than the spatialities of VC (Angel Research Institute, 2018)	Availability is function of legal, regulatory, economic and cultural differences (Cumming and Zhang, 2019) Availability follows geography of entrepreneurial economy – 60–80% angels are cashed-out/current entrepreneurs Thick market (where financiers are more willing to enter a market that is crowded by entrepreneurs and vice versa) (Cipollone and Giorani 2019) and other network effects lead to clusterization of economic activity
Local capital	Angel investments, by preference and outcome, are close to home (Wetzel, 1983; Harrison et al., 2010b) Proximity capital: - Social networks provide deal flow - Due diligence is personalised (Harrison and Mason, 2018) - Post-investment involvement (Politis, 2008, 2016) - Network effects: information and knowledge spillovers (Stuart and Sorenson, 2003) - Regional development drive as VC increasingly centralised and internationalized (Harrison and Mason, 2019; Harrison et al., 2020)	Significant minority (20–35%) invest long-distance and small minority (5–8%) invest internationally (Harrison et al., 2010b; EBAN, 2018; European Commission, 2016) Signalling, certification and credentialization effects (Kim and Wagman, 2016): - Contradictory evidence on extent to which angels do (Schwienbacher, 2007; Elitzur and Gaviols, 2003) or do not (Cumming and Zhang, 2019) provide investees with certification effects in VC-entrepreneur interactions - Implication - in any region the most successful entrepreneurs will choose VC before angel finance even if it is outside the region
Bridging capital	Funding escalator (North et al., 2013; Gregson, 2014; Murzacheva and Levie, 2020) or relay race (Benjamin and Margulis, 2000) – angels ‘pass the funding baton’ to VCs in integrated entrepreneurial finance ecosystem	Collapse of funding escalator (Mason et al., 2019) – angels are now ‘cradle to grave’ investors from start-up to exit (Harrison et al., 2010a; Mason et al., 2015) - Lengthens angel investor’s holding period (Harrison et al., 2010a) - Angels make more follow-on investments in existing portfolio companies than in new (to them) companies (Mason et al., 2015, 2019) - Discouraged demand and downward realignment of entrepreneurs’ expectations (Harrison et al., 2010a) Segmentation of early-stage risk capital market – angels at early stages. VC at later stages (Chemmanur and Chen, 2006, 2014) - Investor risk preferences (Pandher, 2019; Schwienbacher, 2009) - Friend or foe theory (Hellmann and Thiele, 2015) – entrepreneurs prefer VC to angel finance - Angel and VC are dynamic substitutes not complementary – angel-backed companies less likely to obtain VC (Hellmann and Thiele, 2015) - ‘parallel tracks’ (Hellmann et al., 2019; Dutta and Folta, 2016) not ‘stepping stones’ (Cumming and Zhang, 2019)
Productive capital	Widespread belief, in academic as well as policy and practice circles, that angel investment is economically justified (Ali et al., 2017; Dutta; Folta, 2016) Belief that compared to VCs angels expect lower returns over longer time horizon (Shane, 2012) Limited evidence on investment practices and performance (Bonini et al., 2018, 2019; Capizzi, 2015; Botelho et al., 2019; Antretter et al., 2018)	Is it worth it? (Mason and Harrison, 2002): - 50–65% of angel investments written off/fail to return original investment (Gregson et al., 2017; Wiltbank and Boeker, 2007) - High-performing investments are black swan events (Taleb, 2007) – rare and a priori unpredictable - Risk (the prospect of loss – Tennert et al., 2018) is incommensurate with likely returns - Limited evidence of angel learning from experience (Harrison et al., 2015)
Inefficient market	Policy based on an ‘inefficient market’ hypothesis Information and signalling deficiencies (Collewaert et al., 2010) Information symmetries, adverse selection and moral hazard (Landstrom, 1995) Differences in risk-returns expectations held by different market actors (Ivashina and Lerner, 2019; Harrison et al., 2016)	No simple definition of market failure (Martin and Scott, 2000) Market as a matching process (Phelps, 2009) Governments create market failure by leveraging inappropriate finance provision to support artificial demand (Lerner, 2009)
Government support necessary	Intervention necessary to address market failure (Mason, 2009) - Tax incentives - Support for angel group/network operating costs - Coinvestment schemes (Harrison, 2018; Owen and Mason, 2017)	Limited assessment of effectiveness of policy interventions The challenge of assortive matching (Hsu, 2004; Sørensen, 2007; Ewens et al., 2019) Implications of poor risk-adjusted returns (Shane, 2008; Gregson et al., 2013, 2017; Mason and Brown, 2013; Pierrakis, 2011)

which justifies public funding to support private investment activity is an important issue for policy, practice and theory. Given this, in this paper we have two objectives. First, we summarise the current state of knowledge about angel investing, in the form of a series of stylised facts. Second, drawing on a simulation model of the role of tax incentives in angel investing, we reassess the arguments for and justification of government intervention in this market.

2. Background: stylised facts of angel investment

The overwhelming view in both research and policy is that angel investment is a good thing: it contributes to new venture creation and growth, it benefits entrepreneurs, investors and society at large and more of it is better than less. This view rests on a number of 'stylised facts' - a simplified presentation of an empirical finding or a broad generalization that summarizes data, which although essentially true, may have inaccuracies in the detail (Arroyo Abad and Khalifa, 2015) - about angel investment which were either never fully true or have become less so over time. Recognition of this qualifies the panglossian optimism of most angel research and calls into question the basis for the current levels of government support for this market. We identify six stylised facts that dominate angel research and shape the design and delivery of policies to develop the market (Table 1). In each case, the conventional wisdom is being challenged or contradicted by more recent research findings or by the evolution of the angel investment market itself.

The first stylised fact is that angel capital is available capital to which entrepreneurs have access more or less irrespective of their location (OECD, 2011). In fact, although more widely available than institutional VC (Angel Research Institute, 2018), given the predominance of entrepreneurial experience in the angel investor population, angel capital is not universally available but is governed by and reflects the spatiality of the existing entrepreneurial economy. The second stylised fact is that angel capital is local capital. However, a significant minority of angels make longer-distance investments, particularly where the investment is larger, they have specialised investment preferences or where they can co-invest with trusted associates (Harrison et al., 2010b). Increased international angel investment is likely as it is a growing theme in the angel investment and policy communities (Harrison, 2017; Coleman and Robb, 2018).

The third stylised fact is that angel capital is bridging capital in a multi-stage entrepreneurial process, each of which is associated with a different financier, from the '4Fs' (family, friends, fools and fans), through angel investors to VCs and private equity to IPO. However, this sequential view has recently been challenged on the basis of a series of structural changes in the early stage risk capital market (Mason et al., 2019), and angel investors are becoming 'cradle to grave' investors, seeing their portfolio companies through multiple rounds to eventual exit (Harrison et al., 2010a; Mason et al., 2015). The fourth stylised fact is that angel investment is productive investment: however, while angel investors expect lower returns over a longer time horizon than VCs (Shane, 2012), 'is it worth it?' studies (Mason and Harrison, 2002) highlight the high loss rates in angel investing, the rarity of exceptional returns and the need for very large portfolios to generate consistent positive returns (Gregson et al., 2017).

3. Market failure and the equity gap

The fifth stylised fact is that the angel market is an inefficient market characterised by information and signalling deficiencies that make it problematic for would-be investors and investees to meet (Collewaert et al., 2010), information asymmetries between investors and investees that lead to adverse selection and moral hazard problems (Landstrom, 1995), and different risk-returns expectations held by actors in the market (Ivashina and Lerner, 2019).

However, there is no simple definition of market failure (Martin and Scott, 2000). What market failure is not is an observed gap between the presumed demand for investment and the (lesser) supply of capital. Investors may not meet the demand for capital for economically rational reasons, in that the risk-adjusted returns in form of the cost of capital required of investees (e.g. the percent of firm equity surrendered or the interest rate on debt) do not clear the market and match supply and demand. On this basis, the role of government on economic and/or welfare grounds is to adjust risk-reward profile to a market-clearing rate by incentivising or compensating investors to increase the availability of capital (Cumming et al., 2018). However, this entrepreneurial finance market differs from conventional markets in that 'the classical supply-and-demand apparatus does not apply to ... the capital market, particularly the market for capital going to entrepreneurs' innovative projects' (Phelps, 2009, 50). Rather, this market is a matching process which matches financiers with compatible entrepreneurs.

This matching process is not, however, seamless. The need for finance may not be translated into demand for finance, depressing the supply of finance and discouraging demand as ventures realign their aspirations in the light of their perception of the funding market. This represents a *demand failure* as ventures with a need for finance fail to turn that into effective demand. Alternatively, the need for finance may generate a justified demand for finance, and *market failure* is represented in the gap between the justified demand for finance and the non-provision of that finance. There is, however, a further aspect of demand in this market which is rarely discussed: *artificial demand* exists in the form of a demand for finance in the absence of need and occurs when a proposal does not meet the criteria of investors (for example, in terms of growth potential or scalability). To the extent to which artificial demand is reflected in inappropriate finance provision, there is a market failure in terms of the over-supply of finance.

A significant proportion of government intervention in the entrepreneurial finance market, justified on the basis that it is needed to address a supply-side market failure, is in fact associated with the creation of market failure by leveraging inappropriate finance provision to support artificial demand. Government - as an actor in the entrepreneurial finance market, whether as direct investor (public sector venture capital funds), co-investor or through tax incentives - is as much the source of market failure as the solution. As Lerner (2009) has expressed it, with respect to a comparison with the US venture market, although government support has almost always been required to get entrepreneurial finance markets off the ground, 'the low returns in the European venture markets are as

much a consequence as a cause of the massive public interventions in these markets'. This leads inevitably to our final stylised fact.

4. Taxation and angel returns

The sixth stylised fact is that government support is necessary to develop and maintain the angel investment market through support for the establishment and operation of business angel groups and networks, tax incentives and coinvestment schemes (Mason, 2009; Harrison, 2018; Owen and Mason, 2017). There has, however, been little assessment of the effectiveness of these activities. This is particularly the case with respect to tax incentives, which represent the largest financial commitment by government to the development of the angel market.

Although few impact studies of the effects of taxation on angel investment levels in general and investment returns in particular are available (Ali et al., 2017), there is a growing body of research that suggests that tax incentives stimulate angel investment (Cicchello et al., 2019; Barkoczy and Wilkinson, 2019; Cumming and Li, 2013), encourage more angel investment in early-stage high-risk ventures (Lipper and Sommer, 2002; Maula et al., 2005; Aernoudt et al., 2007; Hughes, 2010; Hendon et al., 2012), help correct market imperfections and distortions arising from moral hazard and information asymmetries (Keuschnigg and Nielsen, 2004; Gordon, 2018), support the success of fund-raising campaigns (Ralcheva and Roosenboom, 2016; Signori and Vismara, 2016, 2018), and significantly increase the returns to angel investors (Gregson et al., 2017; Carpentier and Suret, 2016).

On this basis, angel tax credits to subsidize early-stage investors by providing personal income tax credits equal to a certain percentage of their investment irrespective of the investment outcome have been widely adopted (including Canada, UK, France, Germany, Ireland, Portugal, Spain, Sweden, China, Japan, Brazil, Australia and 31 states in the US – Denes et al., 2019; Tuomi and Boxer, 2015), and the wider adoption of tax credits is being actively promoted as a mechanism for expanding the angel market globally (OECD, 2011).

However, while the primary goal of providing tax incentives is to improve after-tax returns for investors as an inducement to take on the risks and uncertainties of investing in this market (Boyns et al., 2003), 'little is known about whether this objective has been reached. Further, data related to the exit of the investors involved in this type of program are extremely scarce' (Carpentier and Suret, 2016, 348), and little is known about the effects of tax incentives on investors and start-ups (Denes et al., 2019). Tax incentives may be counter-productive and socially wasteful if the financial returns from non-viable ventures are unsatisfactory (DeGennaro, 2012). While the availability of tax credits may lead to an increase in the volume of angel investment, this may be in the form of channeling additional investment from new investors with worse access to deals and less experience in screening start-ups into lower quality start-ups launched by less experienced entrepreneurs (Denes et al., 2019). Given the evidence of assortative matching in the angel investment market, such that more experienced investors match with higher quality firms (Hsu, 2004; Sørensen, 2007; Ewens et al., 2019), this leads to the question of whether or not policy-makers should subsidize angel investing to support regional economic and job growth, if this is not generating appropriate risk-adjusted returns (Shane, 2008; Gregson et al., 2013, 2017; Mason and Brown, 2013; Pierrakis, 2011).

Given this paucity of information, we have explored for the first time, the impact of tax on angel investment returns by simulating, using Monte Carlo methods, angel investing portfolios using the same dataset as in previous studies (Gregson et al., 2017; Dutta and Folta, 2016; Zhou and Kato, 2017) (The simulation methodology is summarized in Appendix 1). In this analysis we simulate the effect of both a tax credit (corresponding to the income tax relief applicable at the time of the investment) and of capital gains tax regimes (governing the returns to the investor at exit). Figs. 1 and 2 compare Median IRR (showing portfolios up to 50 investments and all portfolio sizes respectively) for the base (main) simulation, the simulation with capital gains tax, the simulation with the tax credit, and the simulation with both the capital gains tax and the tax credit. Results show that as the portfolio size increases, the tax credit benefit disproportionately outweighs the capital gains tax cost.

The simple modelling of taxes resulted in a 25% reduction of IRR, while the 25% tax credit generates an effective increase in IRR of nearly 50%. As portfolio size increases, the tax credit benefit disproportionately outweighs the capital gains tax cost, and tax credit benefits are actually improved for larger portfolios; effectively reducing the negative impact of capital gains tax. This suggests advantages for more professional angels with larger portfolios and for angel groups. These results confirm the importance of tax incentives for stimulating the flow of angel investment and are consistent with prior research (Cicchello et al., 2019; Barkoczy and Wilkinson, 2019; HMRC, 2016). With the exception of a number of passing comments about the impact of income tax relief on angel investment

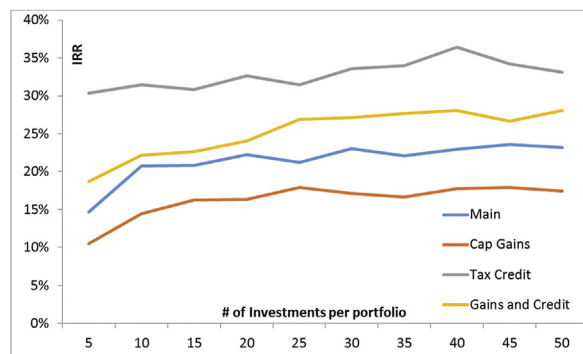


Fig. 1. Taxation effects and median IRR: Portfolios up to 50 investments.

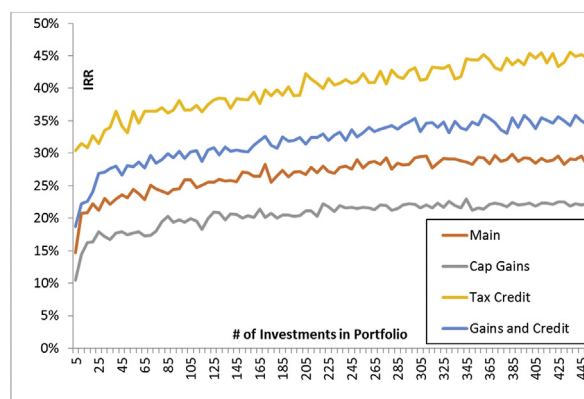


Fig. 2. Taxation effects and median IRR: All portfolio sizes.

providing ‘an immediate guaranteed return on their investments’ (Cicchello et al., 2019; see also Boyns et al., 2003; Mason and Harrison, 2002), the research reported here is the first to demonstrate systematically the impact of taxation on the returns to angel investment.

However, given new evidence that angel investor tax credits are ineffective in promoting high-quality entrepreneurship (Denes et al., 2019), we can conclude that the provision of such incentives adjusts the risk-return profile in such a way as to divorce angel returns from the underlying economic potential of their investee companies on the one hand, and encourages the entry into the market of inexperienced investors on the other. These findings are consistent with those of Carpentier and Suret (2016), who in their review of different tax credit regimes for angels, identify very limited evidence that tax incentives for angels are effective at the firm level. Earlier research by these authors found that the combination of strong tax incentives and lack of selection capacity in tax credit programs ends up directing funds to companies with very low profitability, most of which disappear after a few years (Carpentier and Suret, 2007).

Co-investing policies that attempt to encourage larger investments can also tie up disproportionate amounts of capital. As discussed above, our analysis shows that the investment size–return relationship proposed in prior studies is not clearly supported by the AIPP data-set, calling into question policies based purely on increasing deal size and suggesting that beyond a certain point, increasing angel investment size may actually generate lower returns. There may also be high deadweight from tax incentives if investments already taking place are supported (Hellmann et al., 2019; Dutta and Folta, 2016). These deadweight costs appear to increase with company size, which suggests that tax incentive schemes should target smaller firms (HMRC, 2016). As tax incentives can reduce the effective marginal cost of investing, in theory, more investors should be willing to supply more capital to smaller companies and at lower before-tax expected rates of return. However, from a macroeconomic perspective, tax incentives can be distortionary, leading to sub-optimal allocation of investment (e.g. to start-up companies with a lower rate of return) (European Commission, 2017).

The scale of government support for the early stage risk capital market can be significant (Table 2)¹: the cost of tax relief on qualifying investments in the UK exceeds £1bn annually, relative to gross investment through these schemes of £2.86bn (2017–18 data: EIS £1.93bn; SEIS £189m; VCT £745m). By way of comparison, total venture capital investment in the UK in 2018 was £0.99bn, of which £169m was seed and startup capital (BVCA, 2019).

Despite the opportunity costs involved, however, there is little evidence on the relative importance and economic efficiency of this cost of tax relief. In addition to the expense and complexity in administering tax incentive schemes, the usefulness of tax incentives also depends on the state of the economy and on the possibility of finding suitable investments (Mason, 2009). For many regions, the issue is not one of the supply of investment capital but the lack of demand from growth-aspiring businesses (Parliament, 2012–13). Nor is there any evaluation of front-end tax relief (designed to increase the flow of funds committed to the market) versus back-end incentives (designed to reward success by incentivising exits), which some commentators believe to be more effective and less costly in exchequer terms (Barkoczy and Sandler, 2007), notwithstanding the difficulties in taxing (and giving relief on) gains as they accrue and the portfolio distorting effects of a realisations basis tax (Gammie, 2000). Indeed, the provision for the clawback of tax reliefs within a certain qualifying period (as is the case with the UK’s EIS scheme, for example) can lead to a situation where activities that might otherwise be in the company’s interest are not carried out: in effect, the tax relief becomes more important than the business objective (Law Society 2008).

Angel investment is frequently represented as ‘smart’ money, reflecting the post-investment value-added contribution of entrepreneurially experienced investors to their portfolio companies (Politis, 2008, 2016). However, there has been no assessment of the distributional and welfare effects of incentivising the flow of short-term ‘dumb’ money (passive investment from non-entrepreneurially experienced high net worth individuals that floods the market and skews valuations – Ibrahim, 2014, 13; Boué, 2007) into the market in terms of, for example, its impact on inflating valuations (and hence diminishing prospective returns) (European Commission, 2012). Nor

¹ Although venture capital trust (VCT) investment, made through managed pooled investment vehicles, does not meet the accepted definition of angel investment (investment decisions are taken by the fund manager, not the individual investor, and investments can be made in quoted as well as unquoted companies) it is included here as an important part of the government’s package of support for early stage companies.

Table 2

The cost of tax relief to support the funding of startup and early stage companies in the UK (£m).

	2013–14	2014–15	2015–16	2016–17	2017–18	2018–19	Total	No. of beneficiaries
Income tax								
EIS	450	540	545	590	650	600	3375	35,000
SEIS	85	85	85	95	105	105	560	9600
VCT	130	130	135	170	225	175	965	1300
Capital gains tax								
EIS	115	135	120	125	145	120	720	
Total	790	890	885	980	1125	1000	5620	

Notes EIS – Enterprise Investment Scheme: angels can gain both income tax and capital gains tax relief when they subscribe for eligible shares in small unquoted companies that qualify.

SEIS – Seed Enterprise Investment Scheme: angel investors can receive enhanced tax relief (up to 50% relief) on making investments in very small businesses with growth potential that are at a very early seed or start-up stage, which have only just started trading and may have little or no revenues and very few assets.

VCT - Venture Capital Trusts are investment companies listed on the London Stock Exchange, which raise money from wealthy or sophisticated investors, who receive tax relief on their investments) and use it to invest in young, innovative, and often (but not necessarily) privately-owned companies.

Source HMRC (2019) Estimated costs of principal tax reliefs. Available at https://www.google.com/url?sa=t&rc=j&q=&esrc=s&source=web&cd=27&ved=2ahUKEwib-sfCj9rlAhVNe8AKHUg1C-4FBAWMAZ6BAgJEAI&url=https%3A%2F%2Fassets.publishing.service.gov.uk%2Fgovernment%2Fuploads%2Fsystem%2Fuploads%2Fattachment_data%2Ffile%2F823740%2FJan19_Principal_Reliefs_Final_Revised_for_Marriage_allowance.ods&usg=AOvVaw33-kzn0k9wiGI-GsU0zIC0

has there been any assessment of the mobilising of investment from informal investors (the so-called ‘family, friends and fools’) rather than from value-added angel investors who can impact new venture success (Carpentier and Suret, 2016; Tuomi and Harrison, 2017). Given the evidence on constant returns to scale in the angel finance market, and the corresponding absence of multiple equilibria that would justify government intervention, Cipollone and Giordani (2019, 14) urge caution ‘in justifying direct policy intervention on the demand or on the supply side of angel finance.’

5. Conclusions

The scale of government support for angel investment throws into sharp relief the question of ‘is it worth it?’ In theory, government intervention is justified if market failures exist and policy prescriptions address clear market distortions with measurable effect. Given the distribution of returns to investors discussed above, where investment write-offs are more common than home runs, and the evidence that the tax incentives themselves are a primary driver of returns to investors, the answer to this question is ‘possibly not’.

The paper challenges some accepted ‘stylised facts’ informing current policy prescriptions for the angel market. We specifically note where our simulation model updates our understanding of these facts, as well as where future modelling research could add further value. In conclusion, we highlight three key issues for research and policy: the displacement effect on venture capital; the role of deadweight; and the modelling of back-end incentives.

5.1. Displacement effect on venture capital

Much of the entrepreneurial finance literature has been predicated on the existence of a risk capital ‘funding escalator,’ whereby venture capitalists rely on a deal flow of promising start-up ventures, which have been funded through their early stages by local angels. From a theoretical perspective, angel and VC funding are viewed as a complementary, synergistic investment process (Harrison and Mason, 2000). However, there is little evidence of a ‘stepping stone’ role for angel investment, with angel and VC funding appearing to be dynamic substitutes. The availability of angel capital is governed by and reinforces the spatiality of the existing entrepreneurial economy, with credentializing pushing the highest quality entrepreneurs in a locality to VC rather than angel funding. While our simulation dataset did not include information on VC participation, many of the investments were active more than 10 years, well beyond the time horizon of most VC funds. This presents an extremely interesting opportunity for future research. A dataset that includes VC and angel investing activity, including firms with both angel and VC investors, would enable portfolio-based simulation that compares returns. It could also explicitly consider whether angel investing benefits from displacing or feeding into professional venture capital. No such data set exists (Dutta and Folta, 2016). However, one study which combined data from the AIPP dataset with Thompson One VentureXpert data demonstrated that 58 of 136 angel group backed ventures also received seed/early stage VC investment (39 of which did so in the same year that they received angel investment), and that VC involvement was associated with greater innovation quality and a faster realization of returns (Dutta and Folta, 2016).

This reference to the importance of angel groups challenges another accepted stylised fact, that of the ‘traditional’ model of the solo angel investor committing their own investment capital to a small number of investments. Given the overall distribution of returns and the disproportionate influence of the rare black swan investments, our simulation suggests the need for angel investors to build a significant portfolio of investments to be reasonably sure of making an overall acceptable return. While the ‘professionalization’ of angel

investing through angel groups has allowed for more syndication of investments and portfolio ‘risk-spreading,’ very few angel groups can manage sufficiently large investment portfolios.

5.2. The role of deadweight investments

On the basis of our simulation results and of our summary of the ‘stylised facts’ about the angel market, we suggest that the pre-dominance of supply-side policy prescriptions, through co-investment schemes, tax incentives or direct investment (government VC funds) have leveraged inappropriate finance provision to support artificial demand, resulting in low risk capital returns. While public funding may result in more bad deals getting funded by less experienced or less active angels, there is still no objective way to identify a priori the outlier winners in the early stage risk capital market. This is the problem of deadweight investments, which tie up capital and other ecosystem resources. Future research could extend our modelling work by identifying or building independent investment quality measures into a returns simulation. Deadweight is currently hard-coded into the model via the random selection of investments into each portfolio. The available dataset’s only “measure of quality” is the exit value. Modelling deadweight requires decoupling quality from outcome; this could be accomplished in future research with datasets that have an independent measure of quality (e.g. team prior experience, board qualifications, patents) or via a pure simulation in which a novel quality variable was incorporated that was statistically linked to outcomes.

At the same time, however, if one accepts that there is plenty of investment capital but a shortage of investable deals (Mason et al., 2019), government intervention through the tax system - in the form of front-end incentives in particular - represents an encouragement to individuals to participate in this market in a manner and on a scale that is predicated to result in a loss of their investment capital. This transfers the systemic risk of the cost of incentivising these investments to the general taxpayer citizen in a regressive redistributive manner. The simulation clearly demonstrates that tax credits disproportionately increase the perceived return to angel investing, because the value of near-term tax credits is magnified due to the long hold time of many angel investments. Given that angel research and policy-making have to date prioritised a focus on the supply side of the market we believe that it is also worth considering shifting the focus to the demand side. This would address two emerging problems in the market. First, incentivisation of ‘dumb money’ (Macht and Robinson, 2008) into the market, through provision of tax incentives and other measures, could be restricted in the interests of both the investors involved, the businesses in which they might invest and the government itself, who has to carry the consequences of business failure and underperformance that ensue. Second, improving the effective justified demand for angel investment from high-growth potential investable business ventures would be enabled by focusing attention on investment readiness programmes (Mason and Kwok, 2010; Mason and Harrison, 2004).

5.3. Back-end incentives and investment returns

In light of the evidence on the returns to angels and other issues raised in this paper, we suggest that widespread incentives to encourage the front-end commitment of additional capital to the market could be reconsidered. Future research should explicitly model back-end incentives, such as tax deferments on exit within a given time-frame, to explore ways to provide explicit incentives for successful business growth, exit and reinvestment. However, modelling back-end incentives and their link to outcomes presents an intriguing challenge for exploring policy options for angel investing. It requires two new elements: the policy incentive and the model mechanism. We explore the model mechanism first. One option would be to create a randomized “early exit” variable. As each investment is selected into a portfolio during a run, that variable would determine whether investments with exits take advantage of an earlier, smaller exit opportunity. For example, an investment that takes 8 years to generate 15x return could, based on a separate random number calculation, have an option to exit at 6 years and 10x. In another run, however, the random number calculation might generate no alternatives. Creating the stochastic model for the number of years as well as the return adjustment will require careful consideration; to our knowledge no research exists providing guidance on early exit opportunity prevalence or implementation.

The related question is the nature of the policy incentive. The “early exit” variable is a black box—it assumes that there is some type of exogenous incentive without making it explicit. The obvious policy mechanism, tax relief on early exit, appears to provide tax relief for exiting early on the assumption that investors could have waited longer for a larger exit, which is something angel investors have little control over in practice (Harrison et al., 2016). It is difficult to imagine what information investors would provide to government to justify this. It is also not obvious how the tax relief should be structured: as we have noted above, tax relief on capital gains could include the rollover or carrying forward of capital gains and losses or the provision of loss relief on a more favorable basis than the baseline tax system. Also, the use of minimum holding periods could be structured to support the generation and capture of knowledge spillovers and increase stability to capital structure in a way that reflects angel holding period patterns and norms. The use of maximum holding periods, on the other hand, may encourage investors to prematurely exit investments to retain tax relief and/or only select those investments that mature quickly or are close to the point of divestment. Notwithstanding the danger of a minimum holding period to retain the tax incentives leading to prioritization of tax benefits over business objectives, there is growing consensus that it is more desirable for tax incentive schemes to utilize a minimum holding period, rather than a maximum holding period or having no holding period requirement (European Commission, 2017). Providing the evidence base for such choices is a major future research agenda item.

An alternative would be something like a tax-increment-finance (TIF) policy as in the US, where taxes are deferred to a time when the organization is more able to pay them. Here, the understanding might be that the angel would reinvest some or all of the exit capital (including what would have been paid in taxes) into new deals, and would not have to pay taxes until some or all of those investments are realized. From a modelling point of view, linking the policy to the early exit model mechanism presents a major technical and data challenge. In the case of direct tax relief, the model would presumably generate the potential randomized early exit, generate the

anticipated value of the tax relief, and compare this against a hypothetical investor's IRR preferences. The TIF version requires a further series of calculations to estimate how taxes would be repaid, which would involve running the model recursively, since the expected value to the investor, and the taxes to be paid, are the result of future investing activity.

6. Summary

In summary, we have argued that the rationale for and scale of government intervention in and support for the angel investment market is predicated on a number of stylised facts – the universality and availability of angel capital, the localism of angel investment, the bridging role of angel capital in the 'funding escalator', the productive nature of angel investment, the inefficiency of the market, and the need for government support. The results of recent research into the angel market (in particular the rise of angel groups, the collapse of the funding escalator, and the long-tail distribution of returns on investment) challenge some of these stylised facts. Specifically, we have highlighted the problematic role of angel tax incentives in generating investor returns, attracting inexperienced investors and channelling investment to more marginal businesses. On the basis of this we conclude that the role and scale of government involvement in the angel investment market needs to be seriously rethought.

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Author statement

All authors contributed equally to this paper.

Declaration of competing interest

I can confirm on behalf of myself and my coauthors that there are no conflicts of interest to report.

Appendix 1. Simulation Methodology

Sampled from the largest available angel returns data set, the Angel Investor Performance Project (AIPP) dataset is described in one recent review as the most reliable angel returns dataset (McDonald and DeGennaro, 2016). This has been used in prior analyses (Wiltbank and Boeker, 2007; McDonald and DeGennaro, 2016; Gregson et al., 2017; Zhou and Kato, 2017). It includes information from 86 angel investing groups in North America covering 539 individual investors who made 3097 investments, resulting in 1137 exits (Wiltbank and Boeker, 2007). Our analysis follows that of Gregson et al. (2017). It is based on a cleaned dataset of responses from 13% ($n = 70$) of those investors who reported data on exits. Given that investors may be reluctant to acknowledge or report on unsuccessful exits (Harrison et al., 2016; McDonald and DeGennaro, 2016), selection bias may be present in the results (DeGennaro and Dwyer, 2009; Wiltbank and Boeker, 2007), although there is little evidence of response bias (DeGennaro and Dwyer, 2014). Specifically, we simulate portfolios ranging from 5 to 250 investments, an investing window of 0–10 years, portfolio hold times ranging from 10 to 25 years and incorporate the impact of taxes, including tax-loss benefits associated with writing off investments. In total, we have simulated more than 11 million portfolios, totalling over 240 million hypothetical investments.

First, we addressed the issue of angel investment tax incentives. We ran the simulation analysis to incorporate a 25% tax incentive on angel investments. In this analysis, investors receive a cash tax incentive of 25% of the total investment amount, regardless of the year of investment. We incorporated United States capital gains taxes into the analysis: this currently imposes a 25% tax rate on gains obtained in less than one year and a 15% tax rate on gains obtained beyond one year. Tax losses must be distributed over time at a maximum of \$3000 per year. Because of the technical complexity of incorporating this into the analysis, we have instead simply assumed that tax losses would be recognized in the year obtained. While this is arbitrary and counter to actual tax accounting, it is a necessary simplification to recognize the value of tax loss harvesting.

Second, we report the results of the basic taxation analysis. The tax credit was implemented as a one-time positive cash flow equal to 25% of the investment amount in whatever year the investment was made. As would be expected, this results in a significant positive impact on returns, as most of the credits are obtained in the first year. Capital gains/loss tax was implemented as one-time negative/positive cash flows based on a 25% short-term and 15% long-term rate.

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