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The Science of Business Angels: Unveiling Its Intellectual Structure, Evolution and Emerging Trends

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Abstract

This study examines the intellectual structure of Business Angel research by identifying its main thematic clusters, intellectual turning points and citation burst papers. A co-citation analysis was conducted using data retrieved from the Web of Science Core Collection, comprising 29,168 cited references. The analysis identifies 11 thematic clusters: Screening and Rejection Process, Networks and Professionalisation, Informal Venture Capital Market, Equity Crowdfunding, Business Angels Ecosystem, Investor Signalling, Hybrid Entrepreneurial Finance, Institutional Context and Social Capital, Investment Criteria and Investor Characteristics, Reputation and Entrepreneurial Support Structures and Regulatory Interventions and Incentive Effects. Furthermore, six intellectual turning points connecting otherwise differentiated areas of the field were identified. Citation bursts reveal a progression from broad foundations centred on the informal venture capital market and the Business Angel ecosystem towards more specialised research on investment evaluation and signalling, institutional and regulatory mechanisms, and hybrid entrepreneurial finance. The overlap between these trajectories indicates a cumulative rather than substitutive development of the field. By integrating cluster analysis, intellectual turning points and citation bursts, this study provides a combined structural and temporal reconstruction of Business Angel research, clarifying both its intellectual foundations and the way its research priorities have evolved over time.

Keywords: business angels; entrepreneurial finance; venture capital; intellectual turning points; signalling; co-citation analysis; intellectual structure; bibliometrics

1. Introduction

Business Angels (BAs) occupy a distinctive position in the entrepreneurial finance ecosystem. At the seed and early stages of a venture's life cycle—when uncertainty is particularly high, liquidity is limited and information asymmetries make access to traditional bank financing especially difficult—BAs represent one of the main sources of external finance available to entrepreneurs (Zheng et al., 2021). Their relevance, however, extends well beyond the provision of financial capital. BAs frequently contribute experience, business knowledge, networks, advice and hands-on support, thereby providing what has been described as "smart money" and potentially playing an important role in the development of the ventures in which they invest (Aernoudt, 2005; Lange et al., 2024).

Given this dual financial and non-financial role, understanding how scientific knowledge on BAs has developed is relevant not only for scholars, but also for entrepreneurs

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seeking finance, investors operating within entrepreneurial ecosystems and policymakers designing mechanisms to foster early-stage investment.

Despite the growing academic interest in BAs, relatively few studies have attempted to systematically map this literature, and those that have done so have adopted different methodological approaches. Tenca et al. (2018) combined a structured literature review with bibliometric analysis and inductive thematic coding to identify the main thematic areas and research lines that have shaped BA research. Coronel-Pangol et al. (2022) conducted a bibliometric analysis based on keyword co-occurrence to map the thematic evolution of alternative entrepreneurial finance and identify its main, emerging and future research themes.

However, neither study examines the intellectual structure of BA research by simultaneously identifying its major research clusters, the papers acting as intellectual turning points and the burst papers that have attracted particularly intense scholarly attention during specific periods. In this context, intellectual structure refers to the relationships among the cited references that constitute the knowledge base of BA research, rather than to the publications citing them. Co-citation analysis is particularly suited to addressing this gap because it reconstructs the intellectual structure of a research field from the relationships among the references on which subsequent research is built, rather than from predefined thematic categories. Combining these three perspectives provides both a structural and a temporal view of the development of BA research. The present study covers publications from 2000 to 2025, providing a comprehensive perspective on the evolution of this research field.

Accordingly, this study addresses the following research questions:

RQ1: What are the main thematic clusters that define the intellectual structure of BA research?

RQ2: Which papers have acted as intellectual turning points by connecting different areas of BA research?

RQ3: Which papers have attracted particularly intense scholarly attention over specific periods, and what do these citation bursts reveal about the evolution and emerging trends of BA research?

This study contributes to the literature by providing a more comprehensive and updated mapping of BA research, reconstructing how its knowledge base is organised, interconnected and has evolved over time. By integrating structural and temporal perspectives, the study moves beyond previous classifications of topics or research lines and provides a dynamic understanding of the intellectual development of the field.

The remainder of this article is structured as follows. Section 2 describes the methodology and the co-citation approach employed. Section 3 presents the results, including the identified clusters, intellectual turning points and burst papers. Finally, Section 4 discusses the main conclusions, implications, limitations and avenues for future research.

2. Methodology

This study applies bibliometric co-citation analysis to reconstruct the intellectual structure of research on BAs. Bibliometric methods are particularly suitable for examining extensive bodies of scientific literature because they provide a systematic and reproducible means of identifying relationships among publications that may be difficult to capture through narrative review alone (Zupic & Čater, 2015). Co-citation analysis focuses on the frequency with which two references are cited together by subsequent publications (Jordan-Vallverdú et al., 2024). Repeated co-citation is interpreted as evidence of intellectual proximity, allowing groups of closely connected references to be identified and the knowledge base of a research domain to be mapped (Small, 1973; Small & Griffith, 1974). Accordingly, the approach adopted here does not merely quantify citation impact; it examines the relational structure linking the papers on which BAs research has been built.

The bibliographic information was retrieved from the Web of Science Core Collection (WoS Core Collection). To capture the different expressions used in the literature to describe informal equity investors, the search was conducted on 24 January 2026 across all available fields using the following query: "business angel*" OR "angel investor*" OR "informal invest*".

The search produced 885 documents. These records constitute the citing documents from which the co-citation network was constructed. Collectively, they contained 29,168 cited references. This distinction is important because the 885 retrieved documents and the 29,168 references represent different analytical units: the former provide the source corpus, whereas the latter constitute the intellectual base examined through co-citation analysis. Consequently, the clusters identified below are formed from cited references rather than from the 885 citing documents themselves.

The co-citation network was generated with CiteSpace v. 6.4.R2, a software environment specifically designed to examine the structural and temporal development of scientific knowledge (Chen, 2006). The node type was set to cited reference, and no pruning procedure was applied, thereby retaining the connections generated by the selected configuration. Node selection was based on the g-index (Egghe, 2006), using a scaling parameter of k = 30. Within CiteSpace, k regulates the number of nodes retained in each time slice and therefore affects the size and level of detail of the resulting network (López-López et al., 2026).

Network quality was first assessed through modularity and silhouette. Modularity Q evaluates how clearly a network can be partitioned into distinct communities: values closer to 1 indicate that links are concentrated within clusters rather than distributed indiscriminately across them (Newman, 2006).

Cluster consistency was examined through the silhouette coefficient, which combines internal cohesion with separation from the closest alternative cluster (Chen et al., 2010). For a cited reference x, the coefficient is defined as follows:

$$Sil(x) = \frac{b(x) - a(x)}{max[a(x),\ b(x)]} \quad (1)$$

where $a(x)$ represents the degree of resemblance between a given paper and all the other papers belonging to the same cluster, while $b(x)$ captures the similarity between that paper and all the papers contained in the closest alternative cluster, for each cited reference x.

The coefficient approaches 1 when a reference is substantially closer to its own cluster than to neighbouring clusters. In bibliometric clustering, silhouette values higher than 0.70 are regarded as evidence of a reliable solution (Chen et al., 2010). The weighted mean silhouette obtained indicates very high overall cluster consistency.

Once the network structure had been established, the analysis proceeded in three complementary directions. First, the co-cited references were grouped into thematic clusters representing the principal knowledge streams underpinning BA research. Cluster interpretation was based on the substantive content of the references associated with each group. Second, the analysis examined references capable of linking otherwise differentiated areas of the network. Third, citation bursts were used to introduce a temporal dimension and identify works that experienced unusually intense periods of scholarly attention. Taken together, these perspectives make it possible to examine the field in structural, connective and temporal terms (Lopez-Lopez et al., 2025; Toro-Gallego et al., 2025).

The second analytical dimension relies on betweenness centrality, a network measure that captures the extent to which a node occupies a bridging position between other nodes (Freeman, 1977; Chen, 2005). This property is especially relevant in co-citation analysis because a highly central reference may connect intellectual areas that would otherwise remain relatively separated. Rather than reflecting how often a publication is cited, betweenness

centrality describes its structural position in the network. More specifically, the betweenness centrality of a cited reference w, $C_T(w)$, can be represented as follows:

$$C_T(w) = \sum_{s \neq w \neq t} \frac{\sigma_{st}(w)}{\sigma_{st}} \quad (2)$$

where σ_{st} is the total number of shortest paths between nodes s and t, and $\sigma_{st}(w)$ is the number of shortest paths from nodes s and t that pass through node w.

In CiteSpace-based studies, nodes with betweenness centrality of 0.10 or above are commonly treated as structurally salient bridging references. In this study, such references are interpreted as intellectual turning points because they help reveal connections between distinct research streams and, consequently, changes in the development of the BAs knowledge base (Chen, 2005; Shibata et al., 2007).

Finally, temporal changes in scholarly attention were examined through citation burst detection. CiteSpace implements Kleinberg's (2003) burst detection approach to identify references whose citation activity rises sharply during a delimited period.

Kleinberg's algorithm represents citation activity over discrete time intervals through an automaton with states corresponding to increasing levels of activity. Let b_t denote the number of occurrences of a particular reference during period t, and c_t the total number of observations during that period. The baseline probability is expressed as $p_0 = B/C$, where $B = \sum_{t=1}^{n} b_t$ and $C = \sum_{t=1}^{n} c_t$. States with higher-activity levels are characterised by $p_i = p_0 s^i$, with $s > 1$. The cost of observing b_t occurrences in state i is calculated as follows:

$$\sigma(i, b_t, c_t) = -\ln\left[\binom{c_t}{b_t} p_i^{b_t} (1 - p_i)^{c_t - b_t}\right] \quad (3)$$

The algorithm determines the sequence of states that best represents the observed temporal distribution while imposing penalties on unnecessary transitions between states. A citation burst therefore corresponds to a shift from the baseline state to a state of greater activity, indicating an unusually high concentration of citations over a specific period (Kleinberg, 2003).

Unlike cumulative citation counts, which primarily capture sustained influence, a citation burst highlights the concentration of attention over time (Torres-Pruñonosa et al., 2024). Burst references can therefore reveal periods in which particular publications or topics rapidly gain prominence and can be used to trace shifts in the research agenda (Chen, 2006; Chen et al., 2010). In the present study, these references are referred to as burst papers and are considered jointly with the thematic clusters and intellectual turning points to reconstruct the evolution of BA research.

3. Results

This section presents the results of the co-citation analysis and is organised around the three complementary dimensions corresponding to the research questions. First, the cluster analysis identifies the main thematic areas that constitute the intellectual structure of BA research (**RQ1**). Second, betweenness centrality analysis identifies the papers that have acted as intellectual turning points by connecting different areas of the field (**RQ2**). Finally, citation burst analysis provides a temporal perspective by detecting papers that attracted particularly intense scholarly attention during specific periods, thereby revealing shifts and emerging trends in the evolution of BA research (**RQ3**).

3.1. Cluster Analysis: Intellectual Structure of Business Angel Research

The co-citation analysis reveals 11 major clusters which collectively represent the principal thematic domains underlying the intellectual structure of BA research. Table 1

summarises the main characteristics of these clusters, including their size, silhouette value, mean year, label and thematic description, while Figure 1 provides a graphical representation of the co-citation network. The resulting network shows a modularity Q value of 0.8121 and a weighted mean silhouette of 0.9185, indicating a clearly differentiated cluster structure with a high degree of internal consistency. The individual silhouette values reported in Table 1 provide additional evidence of the coherence of each cluster.

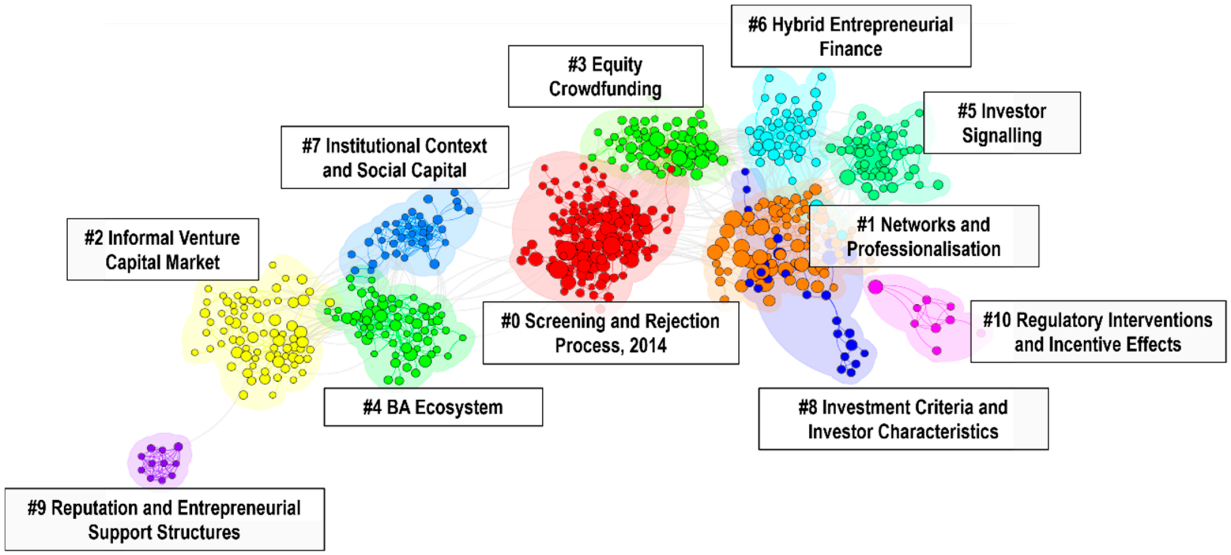


Figure 1. Co-citation network of business angel research.

Importantly, these clusters emerge from patterns of co-citation among the references constituting the intellectual base of BA research and should therefore not be interpreted as predefined thematic categories imposed on the literature. Instead, they reflect groups of publications that subsequent research has repeatedly drawn upon together, revealing distinct but potentially interconnected bodies of knowledge within the field. The following analysis examines the content of each cluster and the principal contributions that define its thematic identity.

Cluster #0 encompasses the **Screening and Rejection Process** as its main research area. At its core, this literature examines how BAs screen investment opportunities and progressively discard proposals under conditions of uncertainty. Carpentier and Suret (2015) show that a substantial proportion of proposals are rejected through informal screening before entrepreneurs reach the face-to-face presentation stage, with a lack of relevant industry experience operating as an important exclusion criterion. This selective process is further explained by Maxwell et al. (2011), who demonstrate that BAs use elimination-by-aspects heuristics to identify critical deficiencies in investment proposals, thereby facilitating decision-making when time and information processing capacity are limited. The screening process, however, extends beyond these formal filtering mechanisms. Mitteness et al. (2012) highlight the role of perceived entrepreneurial passion and its interaction with investors' cognitive characteristics in shaping screening decisions. The relevance of the selection process is also reflected in subsequent venture outcomes: Kerr et al. (2014) find that ventures receiving funding from angel groups exhibit higher survival rates and employment growth than comparable ventures that narrowly failed to obtain funding. Finally, Brown et al. (2018) extend this stream of research towards digitally mediated financing environments by linking successful fundraising to entrepreneurial bricolage and founders' ability to mobilise weak ties through social networks. Taken together, this cluster portrays BA investment as a selective, multi-stage screening process in which filtering mechanisms, decision heuristics,

entrepreneurial characteristics and access to networks jointly contribute to determining which ventures progress towards investment.

Table 1. Main Research Areas in Business Angel Research.

Cluster ID	Size	Silhouette	Mean (Year)	Label	Description
0	125	0.918	2014	Screening and Rejection Process	Examines BA screening and rejection processes, including rejection criteria, elimination heuristics and the effects of entrepreneurial passion and cognitive preparedness on investment outcomes.
1	81	0.847	2019	Networks and Professionalisation	Examines the shift from individual investors to organised BA networks (BANs), focusing on group-based due diligence, portfolio diversification and startup survival.
2	77	0.959	2003	Informal Venture Capital Market	Examines the scale of the informal investment market and key determinants of investment propensity, including prior experience, human capital, social capital and deal flow quality.
3	68	0.915	2015	Equity Crowdfunding	Examines information mechanisms in equity crowdfunding, including information cascades, founder equity retention, entrepreneurial preparedness and sophisticated investors as validators.
4	65	0.895	2007	BA Ecosystem	Examines the BA ecosystem, including public policy, financial and regional conditions and post-investment value creation.
5	53	0.948	2021	Investor Signalling	Examines how entrepreneurial and venture-related signals are transmitted, interpreted and combined by investors, including the cognitive and contextual mechanisms shaping their responses.
6	44	0.901	2020	Hybrid Entrepreneurial Finance	Examines the interaction between BA, crowd investors and other financing actors within increasingly hybrid entrepreneurial finance environments.
7	36	0.946	2008	Institutional Context and Social Capital	Examines how national institutions, social trust and institutional conditions shape informal investment activity and entrepreneurship.
8	27	0.960	2018	Investment Criteria and Investor Characteristics	Examines the criteria investors consider when assessing entrepreneurial opportunities and how investor characteristics shape investment behaviour.
9	11	0.999	2002	Reputation and Entrepreneurial Support Structures	Examines how reputation, referral relationships, strategic conditions and support structures influence entrepreneurial development and access to external resources.
10	9	0.993	2022	Regulatory Interventions and Incentive Effects	Examines how regulatory reforms and incentive schemes shape BA activity, including both their intended effects and the unintended consequences that may arise from policy design.

Cluster #1 centres on BA **Networks and Professionalisation** as its principal theme. This cluster reflects the transition from relatively atomised individual investors towards more organised forms of angel investment, particularly Business Angel Networks (BANs), in which investment practices become increasingly collective and structured. C. Mason et al. (2019) associate this transformation with the emergence of more visible and professionalised angel markets, characterised by more systematic deal flow management and due diligence processes, as well as an enhanced capacity to undertake larger investments and provide follow-on financing. From the investor perspective, participation in these networks also affects investment behaviour. Bonini et al. (2018) show that BAN membership facilitates portfolio diversification, with affiliated angels allocating a larger proportion of their personal wealth to angel investment while reducing their exposure to individual

ventures. The collective dimension also extends to the evaluation process. C. Mason et al. (2017) find that interaction among investors contributes to the development of shared evaluation practices, particularly in identifying weaknesses in entrepreneurial teams as grounds for rejecting investment opportunities. Similarly, Cardon et al. (2017) highlight cognitive preparedness as a particularly relevant positive signal in group evaluations, while entrepreneurial enthusiasm becomes more meaningful when accompanied by personal financial commitment. Beyond internal group dynamics, external validation also contributes to investment assessment: Croce et al. (2017) show that third-party endorsement, particularly from venture capital investors, can operate as a certification mechanism that mitigates initial information asymmetries. Finally, Lerner et al. (2018) provide evidence that organised angel groups can have consequences beyond the investment decision itself, positively affecting venture survival, employment and subsequent fundraising. Taken together, this cluster portrays the professionalisation of angel investment as a shift towards network-based structures in which collective evaluation, portfolio diversification, certification and more formalised investment practices increasingly shape both investment decisions and subsequent venture development.

Cluster #2 focuses on **Informal Venture Capital Market** as its principal research area, examining both its economic relevance and the factors shaping participation and investment behaviour. At the aggregate level, Bygrave et al. (2003) estimate that informal investment represents approximately 1.1% of GDP across the countries examined by the Global Entrepreneurship Monitor (GEM), while also associating this activity with opportunity-driven entrepreneurship and individuals' perceptions of their entrepreneurial capabilities. At the individual level, Maula et al. (2005) show that the propensity to become an informal investor is more closely associated with previous entrepreneurial experience, skills and social capital than with demographic characteristics. Their findings also distinguish investments in relatives, which tend to be more reactive and altruistically motivated, from investments in unrelated entrepreneurs, which exhibit a more proactive and economically oriented rationale. The cluster also addresses the functioning and performance of the informal venture capital market. C. M. Mason and Harrison (2002) shift attention from the supply of informal venture capital to the quality of the investment opportunities available to BAs. Their analysis highlights a quality gap, whereby the functioning of the market may be constrained not only by the availability of capital but also by the presence of poorly developed investment proposals and entrepreneurs who are insufficiently prepared to attract external investors. This issue is particularly relevant in a market characterised by substantial investment risk, with C. M. Mason and Harrison (2002) reporting that 34% of exits resulted in a total loss. From this perspective, the effectiveness of the informal venture capital market depends not simply on increasing the number or financial capacity of investors, but also on improving the quality and investment readiness of the entrepreneurial opportunities presented to them. Finally, C. M. Mason and Stark (2004) examine how BAs assess investment proposals in comparison with other providers of finance, showing that angels place particular emphasis on the entrepreneur and the fit between the investor and the venture, whereas bankers attach greater importance to the financial dimensions of the proposal. Taken together, this cluster establishes Informal Venture Capital as a distinctive segment of entrepreneurial finance.

Cluster #3 addresses **Equity Crowdfunding** as its primary subject of investigation, examining how digital financing environments reshape the interaction between entrepreneurs and investors and, particularly, how different signals can mitigate information asymmetries. Block et al. (2018) place this phenomenon within the broader transformation of entrepreneurial finance brought about by digital platforms, which facilitate more direct interactions between entrepreneurs and investors and increase the visibility of information relevant to investment decisions. Belleflamme et al. (2014) provide an important theoretical

foundation for understanding crowdfunding by distinguishing between models based on pre-ordering and those involving profit sharing, showing how the choice between these forms depends on factors such as capital requirements and market size. Within equity crowdfunding specifically, Vismara (2016) and Ahlers et al. (2015) highlight the importance of founder equity retention as a signal to potential investors, linking greater retained ownership to investor confidence and campaign success. The importance of signalling extends beyond equity retention. Mollick (2014) shows that indicators of entrepreneurial preparedness, including the quality of campaign materials, the absence of spelling errors and the size of the founder's social network, are associated with crowdfunding success. Finally, Vismara (2018) introduces a further dimension by examining information cascades, showing how the early participation of identifiable and sophisticated investors can provide a certification signal that encourages subsequent investors to participate. Taken together, this cluster shows how Equity Crowdfunding has extended entrepreneurial finance into digital environments in which information asymmetries are addressed through multiple signals, including founder commitment, entrepreneurial preparedness, social networks and the observable behaviour of other investors.

Cluster #4 takes the **BA Ecosystem** as its thematic focus. This cluster examines how the broader environment shapes BA activity and how investors contribute to venture development beyond the provision of financial capital. C. M. Mason (2009) examines the role of public policy in supporting the development of BA markets, including the evolution of policy interventions towards mechanisms such as co-investment schemes. However, public intervention does not necessarily produce the intended outcomes. Carpentier and Suret (2007) provide a critical perspective by showing how poorly designed incentive programmes can generate adverse selection and attract lower-quality ventures while discouraging genuine angel investors. The functioning of the market is also influenced by the heterogeneity of its participants. Avdeitchikova (2008) further highlights the importance of the broader financial environment, arguing that the development of informal venture capital is conditioned by the characteristics of national financial systems. In particular, differences between bank-centred and stock market-centred systems can influence the availability of equity finance, entrepreneurs' attitudes towards external equity and their investment readiness. Amorós et al. (2013) add a geographical dimension by examining how differences in regional entrepreneurial ecosystems and public support mechanisms influence informal investment activity. Finally, Politis (2008) shifts attention from the conditions surrounding BA investment to the value created after investment, identifying four roles through which BAs can contribute to their portfolio companies: strategic, supervisory, resource-acquisition and mentoring roles. Taken together, this cluster shows that BA activity is embedded within a broader entrepreneurial ecosystem in which public policy, regional conditions, investor heterogeneity and post-investment involvement jointly shape the functioning and development of the informal investment market.

Cluster #5 focuses on **Investor Signalling** as its main research area and represents one of the more recent streams within BA research. A central component of this literature concerns how signals are transmitted and interpreted in entrepreneurial finance. Colombo (2021) and Svetek (2022) examine the development and fragmentation of signalling research, while Bafera and Kleinert (2023) provide a more systematic framework by organising the signalling process around key elements associated with the sender, signal, receiver and signalling environment. Alongside this conceptual development, the cluster incorporates new approaches to understanding how investors process entrepreneurial signals. Shane et al. (2020), for example, use functional magnetic resonance imaging to examine investors' neurological responses to entrepreneurial passion, providing evidence that investment interest is influenced by cognitive responses to signals conveyed by entrepreneurs. A further

stream of research examines how entrepreneurial signals are interpreted and combined in different contexts. Huang et al. (2022) further demonstrate that entrepreneurial signals operate configurationally rather than in isolation, showing that signals of entrepreneurial credibility and project quality can complement or substitute for one another. Notably, prior failure experience can contribute positively to crowdfunding success when combined with other signals, either by demonstrating learning or by complementing previous success experience. Ralcheva and Roosenboom (2020) further show that observable signals related to venture and team quality, including information about the directors' team and prior external financing, can provide valuable information for predicting funding success in equity crowdfunding. Taken together, this cluster reflects the increasing sophistication of research into Investor Signalling, extending traditional signalling perspectives towards the cognitive, behavioural and contextual mechanisms through which investors interpret entrepreneurial information and respond to entrepreneurial signals.

Cluster #6 investigates **Hybrid Entrepreneurial Finance** as a distinctive research domain. At its core, this cluster reflects the increasing interaction between BAs, crowd investors and other financing actors within digitally mediated entrepreneurial finance environments. Wang et al. (2019) document the complementarity between BAs and crowd investors in equity crowdfunding, showing that angels play an important role in financing larger ventures, while crowd investors contribute both to these campaigns and to smaller ventures that attract less professional investment. Kleinert et al. (2020) further highlight the interaction between different sources of entrepreneurial finance by showing that prior financing can operate as a third-party certification signal, reducing information asymmetries for subsequent investors. Blaseg et al. (2021) further examine the interaction between traditional and alternative sources of entrepreneurial finance, showing that constraints in bank financing increase entrepreneurs' likelihood of resorting to equity crowdfunding, whereas access to other forms of external equity reduces it. D. J. Cumming et al. (2021) extend this perspective by examining the democratising potential of equity crowdfunding as an alternative entrepreneurial finance channel, showing that it can broaden access to external equity particularly for younger entrepreneurial teams and ventures located outside metropolitan areas. Together, these studies portray an increasingly interconnected entrepreneurial finance landscape in which traditional and digital financing channels coexist, interact and, in some cases, complement or substitute for one another.

Cluster #7 analyses **Institutional Context and Social Capital** as determinants of entrepreneurial activity and informal investment. Levie and Autio (2008) provide a theoretical grounding for the GEM model, showing how education and the perception of entrepreneurial opportunities interact in shaping entrepreneurial activity, suggesting that institutional conditions influence how human capital is channelled into new venture creation. Kwon and Arenius (2010) incorporate the social dimension, showing that social capital and trust facilitate the identification and exploitation of entrepreneurial opportunities. McMullen et al. (2008) further demonstrate that economic freedom and institutional conditions influence entrepreneurial motivations, with stronger property rights favouring opportunity-driven entrepreneurship, whereas more restrictive institutional environments can encourage necessity-driven entrepreneurship. Bowen and De Clercq (2008) show that the institutional environment influences the allocation of entrepreneurial effort, with corruption acting as an important constraint on productive entrepreneurship. Bruton et al. (2010) extend this institutional perspective to entrepreneurial finance, showing how the legal and institutional environment shapes the relationship between governance structures and firm outcomes. Finally, Fairchild (2011) introduces a relational dimension, highlighting the role of empathy and trust in mitigating agency problems in entrepreneurial finance relationships. Taken together, these studies show how formal institutions, such as property

rights, legal systems and informal institutions, particularly trust and social capital, jointly shape entrepreneurial activity and entrepreneurial finance.

Cluster #8 explores **Investment Criteria and Investor Characteristics** as its principal research area. This cluster examines both the attributes that investors consider when assessing entrepreneurial opportunities and the characteristics of investors themselves that shape investment behaviour. Ferrati and Muffatto (2021) synthesise the investment criteria identified in previous research, highlighting the predominant importance assigned to the management team—the "jockey"—relative to the business itself—the "horse". Bernstein et al. (2017) provide causal evidence from a randomised field experiment, showing the particular importance investors attach to information about founding teams when assessing early-stage ventures. Gompers et al. (2020) reinforce the importance of human capital in the venture capital context, identifying the management team as a central consideration in both investment selection and subsequent venture performance. Block et al. (2019b) provide a more nuanced perspective by showing that investors also attach substantial importance to venture-related characteristics, particularly revenue growth and product differentiation, alongside the track record of the entrepreneurial team. The cluster also incorporates characteristics of the investors themselves. Block et al. (2019a) show that personality traits are associated with syndication behaviour, with more extraverted BAs displaying a greater propensity to syndicate, whereas more conscientious investors are less inclined towards group investment. Taken together, these studies show that investment decisions reflect not only the characteristics of the venture and founding team, but also differences in the characteristics of the investors making those decisions.

Cluster #9 focuses on **Reputation and Entrepreneurial Support Structures** as its primary subject of research. This cluster examines how reputation, relational networks, strategic context and support structures contribute to the development of entrepreneurial ventures and their access to external resources. Kelly and Hay (2000) show that more active investors improve the quality of their deal flow through private referral channels, including accountants and lawyers, which are activated by a reputation for previous investment success rather than through formal market mechanisms. Lumpkin and Dess (2001) add a strategic contingency perspective, showing that proactiveness is particularly beneficial in dynamic environments and growth-stage industries, whereas competitive aggressiveness becomes more advantageous in hostile environments and mature industries, where competition for customers and resources is more intense. Aernoudt (2004) introduces the role of entrepreneurial support structures, arguing that incubators should operate as dynamic processes that actively connect resident firms with networks of smart capital, including links with BA communities to facilitate access to seed financing. Bottazzi et al. (2004) broaden this perspective by showing that venture capital firms provide entrepreneurial support beyond financing through monitoring, board participation, managerial recruitment and access to business contacts. Taken together, these studies portray entrepreneurial development as embedded in support structures in which reputation, relational networks, strategic conditions and access to organised sources of finance jointly shape the resources available to entrepreneurial ventures.

Cluster #10 centres on **Regulatory Interventions and Incentive Effects** as its principal line of research. This cluster examines how specific regulatory instruments and incentive schemes influence BA activity and whether such interventions produce their intended effects. D. Cumming and Zhang (2023) show that reforms of both corporate and personal bankruptcy laws positively influence angel investment activity across countries, with the strongest effects occurring where both types of reform are implemented. Solodoha et al. (2023), however, demonstrate that regulatory incentives may also generate unintended consequences. Using the Israeli Angels' Act as a natural experiment, they find that a tax

policy designed to encourage angel investment actually reduced the number of BAs investing in targeted seed-stage start-ups, with evidence also suggesting a decline in investment relative to what would have occurred without the policy. Harrison et al. (2020) provide a broader critical assessment of government intervention in angel markets, questioning some of the assumptions used to justify public support and highlighting the need to assess more carefully the effectiveness and distortionary effects of tax incentives. Taken together, these studies show that regulatory interventions can substantially shape BA activity, but their effects depend on policy design and may range from stimulating investment to producing unintended market responses.

3.2. Intellectual Turning Points in Business Angel Research

Having identified the main thematic clusters, the analysis now turns to the references that occupy bridging positions within the co-citation network. These papers can be regarded as intellectual turning points because they connect otherwise differentiated areas of research and facilitate the circulation of knowledge across the field. Their structural relevance is assessed through betweenness centrality, which captures the extent to which a reference lies on the shortest paths connecting other nodes in the network. Following the conventional threshold used in CiteSpace-based co-citation studies, references with a betweenness centrality of 0.10 or higher are considered structurally salient turning points (Chen, 2005; Shibata et al., 2007).

Table 2 presents the papers meeting this criterion, together with their centrality values, cluster membership, methodology employed and country examined. Notably, all the identified turning-point papers are empirical, although they differ in methodological approach. Collectively, these references constitute important connecting elements in the intellectual structure of BA research. The following paragraphs examine their principal contributions.

Table 2. Intellectual Turning points in Business Angels research.

Reference	Centrality	Cluster	Methodology	Country
Avdeitchikova (2008)	0.20	4	Quantitative	Sweden
Amorós et al. (2013)	0.20	4	Quantitative	Chile
C. Mason et al. (2017)	0.19	1	Mixed methods	UK
Carpentier and Suret (2007)	0.19	4	Quantitative	Canada
Cardon et al. (2017)	0.12	1	Quantitative	USA
Brown et al. (2018)	0.10	0	Qualitative	UK

Avdeitchikova (2008), with a betweenness centrality of 0.20, provides a more granular account of heterogeneity within the informal venture capital market by showing that investors may adopt different investment roles depending on the specific investment situation and the resources they are able and willing to contribute. Based on quantitative data from 278 informal venture capital investors and 422 investments in Sweden, the study identifies four investment roles—capital-oriented, knowledge-oriented, classical BA and micro-investor—according to the level of financial and human resource contribution. Importantly, these roles refer to investors' behaviour in particular investment situations rather than to fixed types of investors, allowing investment behaviour to vary across contexts. The results show that the investment role assumed is strongly related to the availability of financial and human capital and to the willingness to provide these resources, whereas the resource requirements of the investee firm are less important in explaining investment behaviour.

Amorós et al. (2013), also with the highest betweenness centrality of 0.20, provide a geographical perspective by comparing the entrepreneurial framework conditions of core and peripheral regions in Chile. The article highlights substantial regional differences in

the conditions surrounding entrepreneurship, particularly in access to finance, infrastructure, public support and market dynamics. Using the GEM National Experts Survey and quantitative evidence from 695 key informants across eight Chilean regions, six of them peripheral, the study compares these regional differences using non-parametric statistics. Although focused on the Latin American context, the results show that experts in peripheral regions perceive poorer access to finance and physical infrastructure than those in core regions, while evaluating general government policy, government programmes and market dynamism more favourably.

C. Mason et al. (2017), with a betweenness centrality of 0.19, examine the reasons why BAs reject investment opportunities. Using an exploratory sequential mixed-methods design, the study combines face-to-face interviews with 30 BAs in Scotland and Northern Ireland with an online survey of 238 BAs across the UK. The results show that the entrepreneur or management team constitutes the main reason for rejecting investment opportunities, particularly when entrepreneurs are perceived as lacking openness, trustworthiness, knowledge, or realism. Rejection decisions are generally based on only one or two reasons, and the study finds no evidence that either the number or nature of these reasons is systematically explained by BA characteristics. The authors suggest that the increasing participation of BAs in organised groups may contribute to the emergence of a shared repertoire of investment approaches and, over time, to greater standardisation in investment assessment.

Carpentier and Suret (2007), with a betweenness centrality of 0.19, provide a critical empirical assessment of the Quebec Business Investment Company (QBIC) programme, a tax-incentive scheme intended to improve SME capitalization and attract BAs. Using an original database of 205 companies financed through the programme, the study finds that the QBIC scheme largely failed to attract conventional BAs, with many participating investment companies instead controlled by existing shareholders or their relatives. The firms financed through the programme also exhibited significantly lower profitability than comparable firms before investment and significantly weaker operating performance afterwards. The authors relate these disappointing outcomes to programme design weaknesses associated with information asymmetry, adverse selection, agency costs and limited incentives for effective monitoring. Although the article belongs to Cluster #4, its focus on tax incentives and regulatory design gives it clear thematic affinities with Cluster #10. This cross-cutting position is consistent with its high betweenness centrality, as highly central references can act as bridging nodes across otherwise distinct intellectual domains.

Cardon et al. (2017), with a betweenness centrality of 0.12, examine how three distinct motivational cues—enthusiasm, preparedness and commitment—individually and jointly influence BA evaluations of funding potential. Using 1995 evaluations made by 72 BAs of 133 live entrepreneurial pitches in the United States, specifically within the Tech Coast Angels network in California, the study provides quantitative evidence from actual investor–entrepreneur interactions. The results show that preparedness has a positive effect on evaluations of funding potential, whereas enthusiasm has no significant positive main effect. Moreover, the effect of preparedness becomes stronger when entrepreneurs have invested more of their own money in the venture. By contrast, the relationship between enthusiasm and funding evaluations varies according to the form of commitment considered and can even become negative when high enthusiasm is combined with substantial investments of personal money or time. The findings therefore show that enthusiasm, preparedness and commitment should be treated as conceptually and empirically distinct cues rather than as interchangeable manifestations of entrepreneurial passion.

Brown et al. (2018), with a betweenness centrality of 0.10, occupy the lower boundary for classification as an intellectual turning point and therefore represent the turning-point

reference with the lowest centrality in the network. The study examines the demand side of equity crowdfunding from an entrepreneur-centred perspective, using entrepreneurial bricolage as a theoretical lens to understand the behaviour of entrepreneurs seeking this form of finance. Based on in-depth qualitative interviews with entrepreneurs from 42 successfully equity-crowdfunded start-ups in the United Kingdom, the authors show that many of these entrepreneurs are experimental and improvisational actors who combine financial resources from friends, family, BAs and the crowd to overcome resource constraints. The study also identifies a transition from strong personal ties towards broader business networks based on weaker ties during the crowdfunding process. Many of the entrepreneurs can be characterised as discouraged borrowers who are attracted to equity crowdfunding by its speed and by the possibility of raising finance while limiting the loss of equity and autonomy. The findings further show that crowdfunding can provide benefits extending beyond the capital raised, including product validation, media exposure, network expansion and improved access to subsequent financing.

An examination of the reference lists of the six intellectual turning-point papers reveals no direct citations among them, as might be expected given their different research emphases. Nevertheless, connections can be identified through shared authorship and the broader intellectual contributions of their authors. Notably, Brown et al. (2018) and C. Mason et al. (2017) share Colin Mason as a co-author. Moreover, Mason's contributions extend across several thematic areas discussed in this study, including Cluster #1 (C. Mason et al., 2019), Cluster #2 (C. M. Mason & Harrison, 2002; C. M. Mason & Stark, 2004) and Cluster #4 (C. M. Mason, 2009). This recurring presence across different research streams highlights his sustained contribution to BA research and reflects a shared scholarly community in which distinct but related intellectual perspectives have developed.

3.3. Citation Bursts and the Evolution of Business Angel Research

Following the identification of the main research clusters and intellectual turning points, the analysis examines the temporal dynamics of BA research through citation burst detection. Citation bursts identify references that experience a sudden and substantial increase in scholarly attention during a specific period, thereby revealing topics and contributions that have gained particular prominence at different stages in the development of the field (Hou et al., 2018; Kim & Chen, 2015).

Table 3 summarises citation burst activity across the different research clusters. The "Cluster" column identifies the cluster to which the burst papers belong, while "Cluster label" indicates its thematic area. "Number of Papers" reports the number of references within each cluster that experienced a citation burst. "Min (Year)" and "Max (Year)" indicate, respectively, the publication year of the earliest and most recent burst papers in the cluster. "Mean (Strength)" reports the average burst strength of the papers in each cluster, calculated using Kleinberg's (2003) algorithm, with higher values indicating a more pronounced concentration of citations over a specific period. "Min (Begin)" identifies the earliest year in which a paper belonging to the cluster began to experience a citation burst, whereas "Max (End)" indicates the latest year in which a burst ended within that cluster. Finally, the "2000–2025" column provides a visual representation of the temporal duration of burst activity, with the highlighted segments indicating the years during which references in each cluster experienced intensified citation activity. The darker blue segment covers the interval between the publication of the earliest burst paper in the cluster and the onset of its first citation burst, while the red segment marks the period from the earliest burst onset to the latest burst ending recorded for that cluster.

Table 3. Citation Burst Papers in Business Angel Research.

Cluster	Cluster Label	Number of Papers	Min (Year)	Max (Year)	Mean (Strength)	Min (Begin)	Max (End)	2000–2025
2	Informal Venture Capital Market	19	2002	2011	5.23	2004	2013	
4	BA Ecosystem	13	2003	2010	5.90	2005	2015	
0	Screening and Rejection Process	42	2007	2018	6.37	2009	2023	
7	Institutional Context and Social Capital	2	2010	2010	4.00	2011	2015	
3	Equity Crowdfunding	15	2013	2018	5.31	2014	2023	
1	Networks and Professionalisation	24	2017	2022	6.63	2017	2023	
8	Investment Criteria and Investor Characteristics	5	2017	2020	5.87	2019	2025	
6	Hybrid Entrepreneurial Finance	3	2019	2021	3.95	2022	2025	
5	Investor Signalling	2	2020	2021	5.52	2022	2025	
10	Regulatory Interventions and Incentive Effects	1	2021	2021	6.67	2023	2025	

The temporal distribution of citation bursts suggests that the evolution of BA research has not followed a simple sequence of independent topics. Rather, the field appears to have developed through several related trajectories in which broad, field-defining questions gradually gave way to more specialised analyses of investment decisions, institutional interventions and emerging forms of entrepreneurial finance.

The earliest burst activity is concentrated in Cluster #2 (Informal Venture Capital Market) and Cluster #4 (BA Ecosystem). These two clusters address relatively broad questions concerning the size and functioning of the informal investment market, the characteristics of its participants, the conditions under which BA activity develops, and the contribution of investors beyond the provision of capital. Their early prominence therefore reflects an initial phase in which the literature was primarily concerned with defining the market and understanding the wider environment in which informal investment takes place.

A second trajectory can be identified in the progressive refinement of research on investment evaluation. Cluster #0 (Screening and Rejection Process) represents the first major concentration of attention in this area and, notably, contains by far the largest number of burst papers in the analysis. The literature focuses on how BAs screen opportunities, apply rejection criteria, and use heuristics and entrepreneurial cues when deciding which ventures should progress through the investment process. Later, Cluster #8 (Investment Criteria and Investor Characteristics) develops this line of enquiry at a more granular level by examining which specific attributes of the entrepreneur, founding team, venture and investor influence investment assessments. The most recent stage of this trajectory is represented by Cluster #5 (Investor Signalling), where attention shifts further towards the mechanisms through which information is communicated, interpreted and combined by investors. Seen temporally, these clusters suggest a gradual movement from identifying how opportunities are filtered towards explaining more precisely why particular characteristics and signals influence investor evaluations.

A related progression can be observed in the institutional dimension of the field. Cluster #7 (Institutional Context and Social Capital) initially directs attention towards the broad formal and informal conditions surrounding entrepreneurship and informal investment, including legal systems, property rights, trust and social capital. In the more recent Cluster #10 (Regulatory Interventions and Incentive Effects), this institutional perspective becomes considerably more specific. Rather than examining the institutional environment as a whole, the literature focuses on particular regulatory reforms, tax incentives, and policy interventions and assesses whether these mechanisms generate their intended effects or produce unintended consequences. Thus, the burst pattern suggests a transition from studying the general institutional context in which BAs operate towards analysing the design and consequences of specific regulatory instruments.

A further trajectory concerns the transformation of entrepreneurial financing mechanisms and the organisation of BA activity. Cluster #3 (Equity Crowdfunding) marks the emergence of digitally mediated forms of entrepreneurial finance, extending traditional questions of information asymmetry and signalling into online investment environments. Subsequently, Cluster #1 (Networks and Professionalisation) reflects a parallel organisational transformation within the BA market itself, as investment increasingly takes place through organised networks and groups characterised by more collective and structured processes of evaluation and due diligence. Cluster #6 (Hybrid Entrepreneurial Finance) represents a more recent development in which these financing channels are no longer examined in isolation. Instead, attention turns to the interaction and coexistence of BAs, crowd investors, venture capital and other financing actors, including the certification and complementary effects that may arise between different sources of entrepreneurial finance.

The temporal sequence therefore points from the emergence of new financing channels and more organised investor structures towards increasingly hybrid financing environments.

To synthesise the temporal patterns identified through the citation burst analysis, Figure 2 illustrates the main trajectories through which BA research has progressively evolved, indicating in parentheses the year in which the first paper within each cluster began to experience a citation burst.

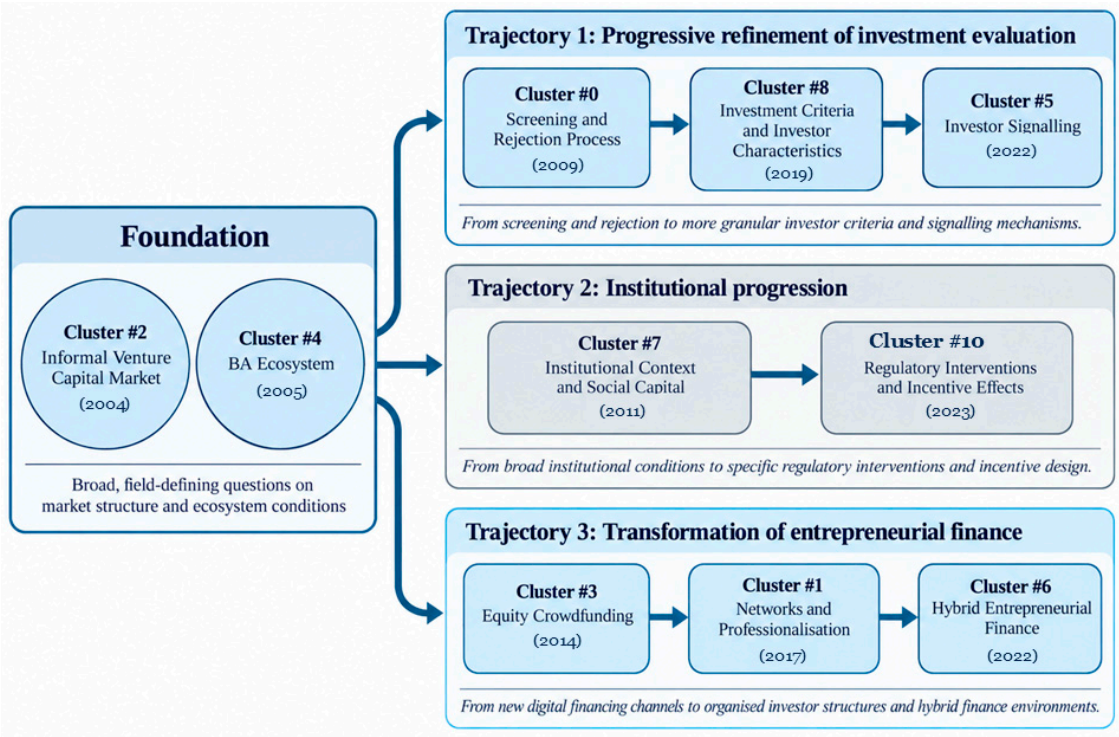


Figure 2. Temporal Trajectories in Evolution of Business Angel Research.

Figure 2 distinguishes an initial foundational stage, represented by the broad study of the informal venture capital market (#2) and the BA ecosystem (#4), from three subsequent and increasingly specialised trajectories: the refinement of investment evaluation (#0, #8 and #5), the progression from institutional conditions (#7) towards specific regulatory interventions (#10), and the transformation of entrepreneurial finance (#3) towards more organised (#1) and hybrid financing structures (#6).

Taken together, these patterns suggest a progressive specialisation of BA research. The earliest bursts were associated with relatively broad questions and subsequent research progressively decomposed these broad issues into more specific mechanisms. Importantly, this evolution should not be interpreted as a replacement of earlier research areas by later ones. The considerable temporal overlap between clusters instead points to a cumulative process in which established themes remain relevant while increasingly specialised lines of enquiry are progressively incorporated into BA research.

4. Conclusions

This section summarises the main conclusions derived from the co-citation analysis of BA research and discusses their implications, limitations and directions for future research.

Eleven research clusters were identified: Screening and Rejection Process (#0), Networks and Professionalisation (#1), Informal Venture Capital Market (#2), Equity Crowdfunding (#3), BA Ecosystem (#4), Investor Signalling (#5), Hybrid Entrepreneurial Finance (#6), Institutional Context and Social Capital (#7), Investment Criteria and Investor Char-

acteristics (#8), Reputation and Entrepreneurial Support Structures (#9) and Regulatory Interventions and Incentive Effects (#10).

The analysis also identified six references with sufficient betweenness centrality to be regarded as intellectual turning points: Avdeitchikova (2008), Amorós et al. (2013), C. Mason et al. (2017), Carpentier and Suret (2007), Cardon et al. (2017) and Brown et al. (2018). Their relevance lies not simply in their citation visibility, but in the bridging positions they occupy within the co-citation network, linking otherwise differentiated areas of the literature.

Finally, the citation burst analysis adds a temporal dimension to this intellectual structure. The earliest concentration of scholarly attention was associated with broad questions concerning the informal venture capital market and the BA ecosystem. From this foundation, three progressively more specialised trajectories emerged: the refinement of investment evaluation from screening and rejection towards investor characteristics and signalling; the movement from broad institutional conditions towards specific regulatory interventions; and the transformation of entrepreneurial finance from equity crowdfunding and organised angel networks towards hybrid financing environments.

From a theoretical perspective, this study provides a structured intellectual roadmap of BA research that can help scholars navigate a literature that has developed across multiple, partially interconnected areas. The identification of the intellectual turning points provides a useful entry point for scholars approaching BA research for the first time. The combined structural perspective provided by the clusters and intellectual turning points, together with the temporal perspective offered by the burst papers, therefore contributes to theory by clarifying both the main bodies of knowledge that underpin BA research and the way in which their prominence and degree of specialisation have changed as the field has matured.

For policymakers, the findings emphasise that regulatory reforms and incentive schemes should be carefully designed and evaluated, as they may stimulate BA activity but can also generate unintended or adverse effects. They also suggest that support for organised BA networks may contribute to more professionalised and structured investment practices.

For practitioners, the findings have differentiated implications for entrepreneurs and BAs. For entrepreneurs, the findings highlight the importance of investment readiness and of communicating credible and consistent signals regarding the founding team, venture quality and commitment, while recognising that investors assess opportunities through multiple criteria rather than relying on isolated indicators. For BAs, the findings highlight the importance of evaluating investment opportunities through a combination of venture and team characteristics and multiple entrepreneurial signals, while recognising that their interpretation may also depend on investor-specific and contextual factors. They also point to the growing interaction between angel investment and other sources of entrepreneurial finance.

This study is subject to several limitations that also suggest directions for future research. First, reliance on the Web of Science Core Collection means that the identified intellectual structure reflects the coverage and citation practices of a single database (Jordan-Vallverdú et al., 2024); future studies could replicate the analysis using combined databases. Second, because co-citation analysis is affected by citation delays, very recent contributions may be underrepresented (López-López et al., 2026); bibliographic coupling or keyword co-occurrence analysis could provide greater sensitivity to emerging research. Finally, co-citation analysis reveals structural relationships among publications but does not directly assess their substantive quality or empirical robustness (Torres-Pruñonosa et al., 2024); focused systematic reviews could complement these findings by examining the content and evidence underlying the principal and emerging research streams.

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