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Venture Capital Co-investment Networks in Four African Startup Ecosystems: Investor Heterogeneity, Lifecycle Dynamics, and Structural Differentiation

Carl Adams Kopati Gbali[1] and Antonio Andreoni[2]

Abstract

Venture capital models developed in mature markets emphasise VC-centred investor communities and dense syndication networks. African VC ecosystems, however, bring together investors with different mandates under distinct institutional conditions. This study examines co-investment across Nigeria, Kenya, South Africa, and Egypt using 2006–2024 data on 85 startups, 1,447 investor–round participations, and 669 investors. It combines social network analysis, TRL-informed stage mapping, chi-square analysis, and 23 semi-structured interviews in Kenya and Nigeria.

Three findings emerge. First, the networks are institutionally heterogeneous: VC firms co-invest with DFIs, impact investors, private equity, corporate venture capital, and angels, consistent with mandate complementarity rather than homogeneous peer matching. Second, participation varies by stage. Angels and VC concentrate earlier; VC remains prominent throughout but declines in share as private equity and corporate venture capital grow later, while DFIs concentrate at intermediate stages, indicating a potential early-stage coordination gap. Third, density is higher in Nigeria and South Africa and modularity highest in Kenya and South Africa; because density differences are not statistically significant, cross-ecosystem network comparisons are interpreted descriptively.

These findings support a networked coordination perspective in which heterogeneous coalitions assemble resources no single investor supplies alone. Strengthening these ecosystems therefore requires attention to the relational infrastructure connecting heterogeneous investors, not only to capital supply.

Keywords: Venture capital, co-investment networks, investor heterogeneity, startup ecosystems, Africa, technology readiness levels.

JEL classification: G24; D85; L14; O16; O55

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1. Introduction

Venture capital syndication has long been understood through the lens of mature markets. In the United States and Europe, co-investment networks are predominantly VC-centric: professional firms form dense, repeated collaboration ties structured around peer matching, certification, and reputation (Lerner, 1994; Manigart et al., 2002). Syndication theory, network models of venture capital, and lifecycle frameworks of staged financing have consequently been built largely on settings in which professional venture capital firms occupy the central coordinating role (Gompers & Lerner, 2004; Sahlman, 1990; Sorenson & Stuart, 2001). The underlying premise is that a relatively homogeneous investor base, composed mainly of venture capital and private equity firms with aligned mandates, time horizons, and return expectations, can supply the resource bundle that staged financing requires: follow-on capital, governance, network access, and entrepreneurial know-how (Hellmann & Puri, 2002; Sahlman, 1990).

This model has shaped how venture capital ecosystems elsewhere are evaluated. Emerging markets are often assessed against the mature-market benchmark, and deviations from VC-centric syndication read as signs of institutional incompleteness expected to lessen over time as ecosystems converge on the dense, VC-centric networks of established markets. However, this assumption does not hold in the African ecosystems studied. Industry data consistently show that African venture capital markets are characterised by the co-presence of development finance institutions (DFIs), impact investors, corporate venture capital (CVC), private equity, and angel investors alongside professional VC firms (AVCA, 2023, 2024), a composition with no parallel in mature VC-centric markets. No single investor class currently provides the full combination of follow-on capital, governance, network access, and know-how across every stage of venture development, so conventional VC-centred accounts do not fully explain how financial and non-financial resources are distributed across differently mandated investor types.

Africa's leading startup ecosystems: Nigeria, Kenya, South Africa, and Egypt, have responded with co-investment structures that depart systematically from this pattern. In the four ecosystems studied, commercial investors, venture capital, private equity, corporate venture capital, and angels account for about 90.0 per cent of investor–round participations; DFIs and impact investors account for about 9.5 per cent; and accelerators for the remaining 0.5 per cent. Critically, investor participation varies across the startup lifecycle: impact investors provide development-oriented capital at early and intermediate stages, while DFIs tend to enter after initial viability is demonstrated; VC firms remain prominent throughout and support follow-on financing and scaling; CVC and PE participation becomes more visible at later stages; and angels concentrate earlier, providing initial capital and local network access. These patterns are consistent with heterogeneous co-investment coalitions assembling a broader resource bundle across the lifecycle.

These four ecosystems account for approximately 67 per cent of recorded venture capital deal volume on the continent (Partech, 2025). Nevertheless, the structural and relational architecture of their co-investment networks- who participates, how investors connect, and how capital is coordinated across the lifecycle- remains underexamined. Existing work documents capital flows and investor counts but does not analyse how heterogeneous investors are connected, how coordination is organised across ecosystems, or how participation varies across the lifecycle.

This gap is consequential because co-investment structure shapes coordination capacity, access to resources, and pipeline continuity (Nanda & Rhodes-Kropf, 2019; Powell et al., 1996). If investor-type

heterogeneity and lifecycle sequencing reflect a functional mode of coordination rather than a transitional feature of nascent ecosystems, then frameworks and policy benchmarks derived from mature markets are mis-specified, not because African ecosystems have failed to converge, but because the VC-centric model those benchmarks assume does not deliver what startups in these contexts need. This study asks whether the observed patterns reflect effective adaptation to institutional constraints or a second-best arrangement with its own coordination costs. Conceptually, the paper treats co-investment as a networked matching process embedded in repeated relational exchange (Powell et al., 1996), arguing that African VC ecosystems are best understood as networked coordination environments in which heterogeneous investors collectively assemble the resource bundle startups require, with participation sequenced across stages. The analytical problem is coordination complexity: how syndicates organise across investor types with different mandates, time horizons, and forms of value-add, rather than competing institutional logics.

Drawing on data covering 85 technology startups, 1,447 investor–round participations, and 669 unique investors between 2006 and 2024, the study combines social network analysis (density, clustering, and modularity), Technology Readiness Level (TRL)-based lifecycle mapping, and chi-square analysis of investor participation across countries and stages, complemented by 23 semi-structured interviews with VC investors, startup founders, and startup executives in Kenya and Nigeria. Three questions guide the analysis: (i) how does investor composition differ from VC-centric syndication patterns? (ii) how do network structures vary across countries? and (iii) how does investor-type participation evolve across lifecycle stages?

The paper makes three contributions. First, it advances the literature on VC market development in emerging economies by specifying the co-investment mechanism through which fragmented intermediation is addressed: investor heterogeneity constitutes a functional response to distributed intermediation, in which the resource bundle is assembled across differently mandated co-investors whose participation is sequenced across the lifecycle. Second, it refines lifecycle theories of venture financing (Gompers & Lerner, 2004; Hellmann & Thiele, 2015) by showing how investor types are positioned across stages of venture maturity in institutionally heterogeneous ecosystems. Third, it contributes methodologically by using TRL-informed stage mapping as a comparative heuristic for examining investor participation where conventional funding-stage labels are inconsistently applied.

The rest of the paper is structured as follows. Section 2 develops the theoretical framework and hypotheses; Section 3 describes the data, methods, and qualitative design; Section 4 presents the results; Section 5 discusses them; and Section 6 concludes.

2. Theoretical background and hypothesis development

2.1. The rationale for co-investment in venture capital ecosystem

Co-investment is a common feature of the venture capital market organisation affecting the division of risk, competences and coordination of investments between various players. Even though different from the syndication structurally, it has similar rationales of risk pooling, resources pooling and coordination (Van Halder & De Maeseneire, 2010). The previous research identifies co-investment as a process of balancing between pooling resources and costs associated with coordinating and taking decisions jointly (Manigart et al., 2006).

From the financial point of view, co-investment represents an application of the modern portfolio theory (Markowitz, 1952) that allows diversifying the portfolio and sharing risks at the times of high uncertainty and making high-quality investments without exceeding the allocation limits (Lerner, 1994; Brander et al., 2002). From the resource-based point of view, co-investment gives an access to the complementarity competences, industrial expertise, experience of due diligence process, governance and monitoring (Manigart et al., 2006; Wright & Lockett, 2003). From a deal-flow perspective, it supports pipeline formation by expanding access to vetted opportunities and strengthening an investor's sourcing position (Lerner, 1994; Lockett & Wright, 2001; Sorenson & Stuart, 2001); since scarce unevenly distributed deal flow means investors often enter opportunities through trusted intermediaries and repeated relationships.

These motivations persist through the entire investment process cycle, where, in the pre-investment stage, the sources of deal generation and referral deals depend on these motives (Lockett & Wright, 2001; Manigart et al., 2006); during the investment stage, there is risk-sharing and due diligence signals coming from partners' collaboration (Brander et al., 2002; Cumming, 2006; De Clercq & Dimov, 2004; Lerner, 1994); in the post-investment stage, co-investors offer complementary monitoring capabilities and local market knowledge (Fritsch & Schilder, 2008); and finally at the exit stage, extended network relationships increase exit opportunities and create co-investments in the future (Manigart et al., 2006; Schilder, 2007). All these motivations imply that co-investment goes beyond being just an economic activity to become a coordination mechanism helping investors organise their resources and handle uncertainties throughout the venture life cycle.

2.2. Co-investment as a networked matching process: heterogeneous investors and repeated ties

Co-investment decisions are integrated in repeated interactions that create relational structures over time. A network perspective analyses co-investment as a relational system in which investors coordinate through collaboration rather than acting independently (Powell et al., 1996). Networks emerge as a result of partner selection, which is influenced by benefits, costs of coordination and agency (Manigart et al., 2006).

In mature venture capital (VC) markets, researchers have studied this matching process primarily within homogeneous communities of professional VC firms. U.S. and European syndication networks are largely VC-centric, with syndication functioning as both a risk-sharing mechanism and a certification device, relying heavily on finance-based rationales (Lerner, 1994; Manigart et al., 2002), with finance-based rationales dominating and resource-sharing and deal-flow considerations playing secondary roles (Lockett & Wright, 2001). Partnership decisions are determined by quality cues, experience, and investor identity, which minimise ambiguity and guide co-investment partnerships in the formative stage (Khavul & Deeds, 2016). The theory relies on the assumption of investment actor homogeneity and the institutional setting that enables peer matching based on quality cues.

The two premises are invalid for developing venture capital markets. Namely, the underlying assumption is that the institutional context affects co-investment partner choice and coalition formation. In India, banks and insurance firms became active strategic players as the institutional setting made them both equity investors and creditors (Panicker et al., 2023). In Brazil, the extent of investor influence on firm strategy was determined not only by the investor type but also by the interaction of investor characteristics and macro-institutional setting (Campos Fonseca et al., 2019). Thus, the same types of investors can behave differently depending on the institutional setting, which means that there is more to the influence of

investors than their heterogeneity. Accordingly, co-investment networks in emerging countries are expected to have heterogeneous structure rather than the homogeneous structure observed in mature countries.

This approach is highly relevant to African venture capital markets, where co-investment networks include venture capital funds, development finance institutions (DFIs), impact investors, corporate venture capital (CVC) divisions, private equity funds, accelerators, and angel investors (AVCA, 2023, 2024) (see Appendix C). Indeed, there is empirical evidence that the heterogeneity of investors is institutionally patterned in that in Nigeria, due to weak regulatory regimes, coalitions are created to combine public and private sources of fund (Ekanem et al., 2019); in Egypt, the decision-making process is oriented towards fund constraints rather than startup quality (Ismail & Medhat, 2019); and in South Africa and Kenya, despite the presence of development funds, financing gaps in the early stages remain (Kato & Chiloane-Tsoka, 2024). In African fintech ecosystems, investor heterogeneity is connected with founder identity, network structure, and maturity (Kabengele & Hahn, 2025). Altogether, coalition creation in African ecosystems is driven by mandate complementarity of investors that have different but complementary mandates. This contrasts with the peer-based matching observed in mature VC ecosystems.

All this highlights weaknesses in the framework of co-investment in emerging venture capital markets. Namely, the literature suggests that the intermediary function is fragmented along the three lines of capital supply, access to the relational network, and governance and knowledge provision (Ahlstrom & Bruton, 2006; Da Rin et al., 2006; Lerner & Schoar, 2005). If there is no single investor able to provide the whole set of resources needed, co-investment coalitions become inevitable to facilitate the coordination of interests. Thus, repeated co-investment in this situation will result in the emergence of network structures characterised by mixing of investor types and mandate-complementary coalitions.

Hypothesis 1: *African VC co-investment syndicates exhibit institutional heterogeneity, incorporating DFIs, impact investors, CVCs, PE firms, and angels alongside traditional VC firms, consistent with mandate complementarity rather than the predominantly VC-centric peer matching described in mature-market syndication research.*

2.3. Startup lifecycle and investor specialisation: stage-based patterns in co-investment networks

Startups' progression through their lifecycles goes through several stages including pre-seed, seed, growth, and exit, all characterised by different levels of uncertainty, capital intensity, and governance. In the theory of staged financing, investor involvement is expected to vary throughout the lifecycle, with risk-tolerant and active investors involved in earlier lifecycle stages while more formal and institutional investors becoming increasingly important as ventures progress (Gompers, 1995; Hellmann & Thiele, 2015; Sahlman, 1990). The above processes take place due to decreasing levels of technological and market uncertainty, which allows for increasing participation of investors with lower levels of tolerance to risk.

In African ecosystems, the dynamics of startup progression is additionally influenced by institutional factors constraining the behaviour of investors. Development-oriented investors such as DFIs act within mandate conditions requiring them to be able to prove that their activity produces development impact and there are market failures, which makes them less likely to participate at early stages and less likely to be present even in the latter stages, where there is already sufficient commercial return to be gained. They are most likely to be active at intermediate stages where there is some traction but still existing market failures. It can be considered a deviation from the theory of staged financing, because in addition to the declining

uncertainty, investor coalitions along lifecycle stages will also depend on institutional risk in African funding ecosystems. Empirical research based on the South African and Kenyan ecosystems reveals that venture capital participation is consistent with institutional constraints in African environments (Kato & Chiloane-Tsoka, 2024), indicating persistent lack of early-stage funding despite the existence of development-oriented capital. In a similar way, empirical research conducted in the Chilean ecosystem indicates the existence of structural financing gap for impact investors, with public capital supporting early stages while expansion-stage financing is hard to obtain (Viglialoro et al., 2024).

The key challenge is related to the consistency of the operationalisation of lifecycle stages in each country. Terms like "seed", "Series A", or "growth" are often used inconsistently, and they differ greatly in terms of their meaning especially in African context. For this reason, the current study relies on the Technology Readiness Level (TRL) framework (Mankins, 1995) to match funding stages with TRLs. Details on operationalisation are provided in section 3.8.

Hypothesis 2: *Investor-type participation in African co-investment syndicates is systematically stratified across TRL stages, with angels and VC firms more prominent at lower TRLs, DFIs concentrated at intermediate TRLs (entering once initial viability is demonstrated but market failures persist), and private equity and corporate venture capital more prominent at higher TRLs.*

2.4. Cross-country variation in co-investment structures: network theory and the African case

In developed VC ecosystems, the structure of co-investment networks is characterised by density, clustering, repeated syndication links, and hierarchical core-periphery structures in which important actors occupy central positions(Burt, 1992; Sorenson & Stuart, 2001) and core-periphery hierarchy with dominant actors on centre positions (Rombach et al., 2014). The latter is a result of frequent collaboration among investors, where clustering means the existence of tightly connected investor communities that share common partners. Modularity measures to what extent network separates into different investor groups and shows low level of tie between clusters. In general, all of these measures describe the architecture of relations through which capital and information flow is coordinated and which responds to the institutional environment in which co-investment networks form. Empirical findings show that this network architecture has strategic implications: venture capital funds (VCFs) with network ties associated with syndication refer their investment to other VCFs faster and invest more money because networks reduce information sorting cost and idiosyncratic risk (Rabi & Petty, 2026).

Cross-country evidence shows that institutional environment systematically shapes the structure of venture capital networks. Groh and Liechtenstein (2012) prove that capital market development, good governance, and investor protection determine the structure of VC activities across countries. Lerner & Schoar (2005) find that weaker legal enforcement leads to increased relationship-based coordination compared to contract. In situations when co-investment coalitions form under high coordination complexity, the network becomes more modular because investors cluster according to compatible mandate pairs and coordination costs limit bridging ties across clusters. In case of a dominating coordination logic, network structure becomes more dense and less modular. Therefore, differences in institutional environment between countries should lead to differences in the structure of networks even for countries that have the same level of development.

Differences in institutional environment in terms of regulation development, capital market depth, and maturity of exit market should be observed in Nigeria, Kenya, South Africa, and Egypt and will result in structurally different co-investment networks (AVCA, 2023, 2024, 2025). Structure of the network determines the coordination capability: bridging ties of actors connecting segmented investor groups contribute to information flow and continuity of syndication, while modular networks centralise coordination risks in hands of a few cross-cluster connectors, leading to disruption of capital flow (Sorenson & Stuart, 2001; Hochberg et al., 2007).

Hypothesis 3: *Co-investment network structures, density, clustering, and modularity, vary across African ecosystems, consistent with differences in institutional conditions and investor-type composition.*

3. Methodology

3.1. Data overview

This research uses venture capital transaction data collected from Crunchbase, cross-referenced with the Big Deal dataset, where any inconsistencies are sorted out manually. In total, this database contains 85 technology-oriented startup companies based in Nigeria, Kenya, South Africa, and Egypt over the period from 2006 to 2024. This sample consists of 1,447 investor-rounds by 669 investors. Investor-round is an event when one investor invests in a particular fundraising round; thus, if there are five investors participating in one fundraising round, there will be five investor-round events. In descriptive analysis, startups, rounds, and investor-rounds are used as units of analysis, while in network analysis – investor-nodes and investor-investor co-investment ties. Due to the observational design of the quantitative approach, findings are considered associations and structural patterns, not causality.

3.2. Sample selection and survivorship bias

This sample includes only technology ventures that experienced several funding rounds from the Pre-Seed/Seed stage to subsequent stages for which the data is available. Such a sampling strategy will allow us to create a longitudinal sample with enough depth to observe the presence of investors at various stages of financing and build co-investment networks.

Such an approach creates a survivorship bias because the firms that were unable to continue their operation after the first round of financing are under-represented. Firms that receive multiple rounds of financing tend to develop more co-investment relationships that might increase their network density and clustering compared to the average startup firm. Thus, network indicators can be understood as depicting the characteristics of firms' successful financing history rather than the overall venture capital ecosystem of Africa. The degree and specifics of such a bias might differ between countries depending on the extent of the availability of Crunchbase data in different African countries.

3.3. Geographic scope

Nigeria, Kenya, South Africa, and Egypt were selected because of their leading roles in Africa's VC ecosystem, geographic coverage across four African regions, and availability of consistent investment data. Together they account for approximately 67 per cent of recorded African VC deal volume over the study period (Partech, 2025).

3.4. Key variables

The analysis employs categorical, ordinal, continuous, and network-based variables capturing investor characteristics (type, country), startup maturity (funding stage, TRL), co-investment structure (syndicate size, co-investment frequency). Detailed variable definitions and construction procedures are provided in Appendix B.

3.5. Descriptive overview of venture capital ecosystems

The analysis first describes ecosystem composition across countries, time, funding stage, sector, investor type, and capital deployment. Counts of deals refer to funding rounds, while investor-type shares refer to investor participations unless otherwise stated. These descriptive patterns provide the context for the subsequent network and compositional analyses**.**

3.6. Co-investment network construction and analysis

We use social network analysis (Wasserman & Faust, 1994) to examine the structure of investor co-investment relationships.

3.6.1. Network construction

Specific country networks are based on investor involvement in rounds of funding. Undirected edges are drawn between two investors if they participate together in any funding round involving two or more investors. Rounds of funding that involve only a single investor are left out of network construction but considered in descriptive statistics. Edge weights are based on repeated co-investment among investor pairs. Country networks are constructed separately.

One-mode projection of the network to the investor set allows to directly analyse investors' structural positions within the network and compare topology of the networks in different countries(Sorenson & Stuart, 2001; Wasserman & Faust, 1994). Network density, clustering, and modularity are measured based on the binary adjacency matrix. It should be noted that a projection of a round of funding with k investors produces k(k-1)/2 pairwise links, hence slightly inflating clustering. Therefore, clustering cannot be used as direct evidence of repeated syndication; it is measured using weighted links.

Differences in network density between pairs of countries are tested using 1,000 iterations of the permutation procedure, Kenya being the reference ecosystem. Investors are randomly assigned in country-specific networks of the same size, generating the distribution under null hypothesis, where country-investor association is broken. The p-value is the proportion of random permutations in which the absolute difference in density is as great as in the observed network configuration. Taking into consideration unequal data availability, the significance means difference in observed network structure and not the population.

3.6.2. Visualisation

Investor types are categorised identically in country-network visualisation to facilitate visual comparative analysis of actors' compositions and network positions.

3.7. Chi-Square analysis of investor types across countries

Cross-country and cross-stage variations in investor compositions are assessed through a chi-square test of independence (Agresti, 2002). Participation is the unit of analysis. Since the same investor can take part

in several financing rounds, the observations are not independent. For that reason, chi-square statistics and observed vs. expected deviations are used interpretively to discern the degree and direction of compositional differences. Effect sizes, such as Cramér's V in the case of TRL analyses, are taken to be the actual evidence of compositional patterns while p-values are disregarded.

3.8. TRL-Based descriptive analysis of investor participation

In order to explore whether there are variations in investor participation in different stages of technological maturity of startups, TRL framework is used as the indicator of technological progress from idea to market entry. TRL has been adopted by the European Commission and is used in the TRL thresholds of Horizon 2020 and the EIC. Accelerator to define eligibility for funding tools for innovations (Héder, 2017). TRL has been explored as the R&D capability and project ranking tool for resource-limited SMEs and startups (Rodríguez López et al., 2023). Recent peer-reviewed literature empirically explores the use of TRL for technological maturity of startups in developing-country context and finds that TRL 4-7 is the "valley of death" when it comes to financing gap between government-funded R&D support and private-sector financing (Prado et al., 2026).

The following mapping of the funding stages is consistent across countries: Pre-Seed/Seed to TRL 1-3; Series A to TRL 3-4; Series B to TRL 5-6; Series C to TRL 6-7; and Series D+ to TRL 7-9 (Table 1). The corresponding country-level mapping, showing dominant investor participation at each stage, is reported in Appendix A (Table A1).

Table 1. TRL stage development

TRL Stage	Technology Development Stage	Startup Stage
TRL 1–3	*Early research and concept development*	*Pre-Seed, Seed*
TRL 3–4	*Prototype development and validation*	*Series A*
TRL 5–6	*MVP, proof of concept, early market entry*	*Series B*
TRL 6–7	*Pilot-scale deployment, early traction*	*Series C*
TRL 7–9	*Full commercialisation, scaling, and exits*	*Series D and beyond*

Source: Authors' compilation

This mapping is more of a theoretical tool than an accurate calibrator. The interview evidence from Kenya and Nigeria seems to confirm the process from validation of the concept in the Pre-Seed/Seed stage, to traction in the Series A stage, and scaling from Series B onwards. However, there can be deviations from this scale in certain cases, and the mapping assumes fairly consistent correspondence of technological maturity and funding stage in different countries.

Two specifications serve as a test of robustness. Specification A differentiates between Seed and Pre-Seed stages and increases TRL borders. Specification B discards the TRL map and uses standard Early/Growth/Late-stages. Findings will be outlined in Section 4.4.1.

3.9. Qualitative data and triangulation

Semi-structured interviews with VC investors, startup founders, and startup executives in Kenya and Nigeria complement the quantitative analysis by providing interpretive evidence on co-investment behaviour, investor collaboration, and network formation. Twenty-three participants were selected purposively, and interviews were conducted between April and September 2025 (Appendix D, Table D1). Ethical clearance was obtained from the authors' institutional research ethics committee; all participants provided informed consent and were anonymised. Data were analysed using hybrid thematic coding (Braun & Clarke, 2006), combining deductive codes derived from the hypotheses with inductive codes emerging from participant accounts. Coding was conducted by the lead researcher, with credibility strengthened through member-checking, negative-case analysis, and an audit trail linking raw data to themes (Lincoln & Guba, 1985; Tracy, 2010).

Because interviews cover only Kenya and Nigeria, qualitative interpretation of mechanisms is restricted to these two ecosystems. South Africa and Egypt are interpreted from the quantitative evidence alone. Qualitative evidence is therefore used to corroborate and contextualise observed patterns, including mandate complementarity, lifecycle entry, and bridging investors, rather than as an independent test of the hypotheses.

4.1. Results

4.1.1. Descriptive statistic

Funding activity expanded after 2014, peaking in 2021 before moderating in line with global cycles (Table 2). Fintech dominates deal volume and capital deployed, followed by Healthtech, Edtech, and B2B E-commerce (Table 3). Venture capital firms lead investor participation, active across all startups and most rounds, while private equity and corporate venture capital account for substantial shares of capital deployed (Table 4). Nigeria is the leading ecosystem in both deal volume and capital raised, followed by South Africa, Kenya, and Egypt (Table 5).

Stage-level dynamics reveal the key shift this paper examines (Table 6): average investors per round rise from 3.6 at Pre-Seed to 7.9 at Series D, while VC participation falls from over 80 per cent at Pre-Seed to around 50 per cent at Series C before recovering at Series D, as private equity and corporate venture capital become more prominent and DFIs concentrate at intermediate stages.

Table 2. Startups, participations and capital raised by year, 2006–2024

Year	Startups	Pre-Seed	Seed	Series A	Series B	Series C	Series D	Participations	Funds_Raised
2006	1	0	0	1	0	0	0	1	0.006
2010	1	0	1	0	0	0	0	1	0
2011	1	0	0	0	2	0	0	2	0.012
2012	3	0	1	1	1	0	0	3	0.004
2013	3	0	5	3	0	0	0	8	0.003
2014	5	0	31	1	1	0	0	33	0.013
2015	10	0	19	23	0	0	4	46	0.053
2016	9	2	45	7	11	0	1	66	0.064
2017	23	11	37	22	12	18	1	101	0.162
2018	18	5	20	20	22	16	0	83	0.147
2019	31	6	37	65	49	0	13	170	0.512
2020	29	10	44	52	37	9	8	160	0.253
2021	41	35	118	55	51	47	14	320	1.348
2022	34	15	63	67	52	18	22	237	0.989
2023	22	17	45	9	63	8	0	142	0.263
2024	16	0	21	37	12	4	0	74	0.224

Note: Funds Raised reported in billion USD.
Source: Authors' analysis of Crunchbase data.

Table 3. Startups, participations and capital raised by sector

Rank	Industry	Startups	Participations	Funds Raised (Billion USD)
1	Fintech	29	464	2.061
2	Healthtech	7	140	0.203
3	Edtech	5	109	0.425
4	B2B E-commerce	6	101	0.25
5	Insurtech	6	88	0.078
6	Agritech	4	79	0.173
7	Tech Talent Marketplace	1	68	0.181
8	HRTech	4	57	0.034
9	LogisticsTech	3	43	0.112
10	RegTech	1	38	0.031

Source: Authors' analysis of Crunchbase data.

Table 4. Startups, participations and capital raised by investor type

Investor Type	Startups	Participations	Funds Raised (Billion USD)
Venture Capital	84	975	2.579
Angel Investor	38	127	0.117
Private Equity	52	110	0.581
Corporate Venture Capital	40	90	0.339
Impact Investor	32	89	0.263
DFI	22	49	0.167
Accelerator	5	7	0.006

Source: Authors' analysis of Crunchbase data.

Table 5. Startups, participations and capital raised by country

Country	Startups	Participations	Funds Raised (Billion USD)
Nigeria	26	539	2.011
South Africa	19	348	1.051
Kenya	21	303	0.52
Egypt	19	257	0.469

Source: Authors' analysis of Crunchbase data.

Table 6. Round-wise summary of co-investment activity across all countries.

	All	Pre-Seed	Seed	Series A	Series B	Series C	Series D
Unique Startups	85	25	64	57	39	14	5
Total Investor Participations	1447	101	487	363	313	120	63
Unique Investors	669	70	308	255	219	98	48
Avg Investors per Round	5.39	3.61	5.45	4.7	6.55	6.67	7.88
Total Funds Raised (M USD)	4051.79	78.83	191.42	659.67	1098.57	1302.2	721.1
Startups with ≥1 co-invested round	83	21	55	46	36	14	5
% Accelerator	0.5	2	0.2	0	1	0.8	0
% Angel Investor	8.8	5	17.2	5.8	4.2	2.5	1.6
% Corporate Venture Capital	6.2	0	2.7	6.9	10.9	8.3	12.7

% DFI	3.4	1	0.8	3	7.3	6.7	3.2
% Impact Investor	6.2	3	3.9	7.4	7	12.5	4.8
% Private Equity	7.6	6.9	3.3	7.7	9.6	16.7	14.3
% Venture Capital	67.4	82.2	71.9	69.1	60.1	52.5	63.5

Note: Percentages show the share of investor–round participations at each stage. "Startups with ≥1 co-invested round" counts unique startups with at least one round involving two or more investors. Stage totals may exceed the overall count because startups can appear at multiple funding stages.

4.2. Co-investment network structure across ecosystems

4.2.1. Network-level statistics

Nigeria and South Africa show higher network density than Kenya and Egypt (0.118 and 0.130 versus 0.087 and 0.098), and shorter average path lengths, consistent with more connected structures (Table 7). Clustering is uniformly high (0.91–0.94), consistent with cohesive co-investment structures across ecosystem sizes; as noted in Section 3.6.1, these high values partly reflect the clique-forming effect of one-mode projection, so they should not be read on their own as evidence of repeated syndication, which is instead indicated by the weighted tie structure examined below. Kenya and South Africa show higher modularity (0.60) than Nigeria (0.51) and Egypt (0.56), indicating greater segmentation into distinct investor clusters.

A permutation test (1,000 iterations) finds no pairwise density difference to be statistically significant (all $p > 0.8$). These configurations are broadly consistent with Hypothesis 3 in direction, but because no pairwise difference reaches significance, the cross-country structural differences are interpreted as entirely descriptive rather than established. Hypothesis 3 is therefore only partially supported.

Table 7. Co-investment network metrics across four African ecosystems

Metric	**Kenya**	**Nigeria**	**South Africa**	**Egypt**
Number of investors	191	269	212	141
Number of co-investment ties	1,585	4,262	2,897	971
Network density	0.0874	0.1182	0.1295	0.0984
Average clustering coefficient	0.9292	0.9090	0.9442	0.9104
Average path length†	2.3849	2.1138	2.2321	2.3609
Modularity	0.5968	0.5057	0.5993	0.5603
Permutation test p-value (vs Kenya)	ref.	0.892	0.810	0.943

Note:: Networks are unipartite investor–investor projections; edge weights capture repeated co-investment across startups. Average path length is calculated on the largest connected component. Permutation tests use 1,000 iterations with Kenya as the reference; no density difference is statistically significant at $p < 0.05$.

Source: Authors' analysis of Crunchbase data

4.2.2. Network composition and ecosystem architecture

Across all four countries, VC firms occupy central positions as primary coordinators of deal flow and co-invest with a heterogeneous set of partners; however, the positioning of other investor types varies systematically by ecosystem (Figure 1). Kenya features the strongest VC–impact investor tie of any network (edge weight = 13), indicating a blended-finance structure (Figure 2). Egypt is more private-equity-oriented, with PE strongly tied to VC, CVC, and angels, and impact investors comparatively peripheral (Figure 3). Nigeria shows dense VC-centred ties with strong links to angels, PE, and CVC (Figure 4). South Africa exhibits the densest network, with angels prominently embedded through strong ties to VC and CVC (Figure 5). These compositional configurations are consistent with the cross-country differences anticipated in Hypothesis 3, describing observed patterns rather than confirming population-level differences.

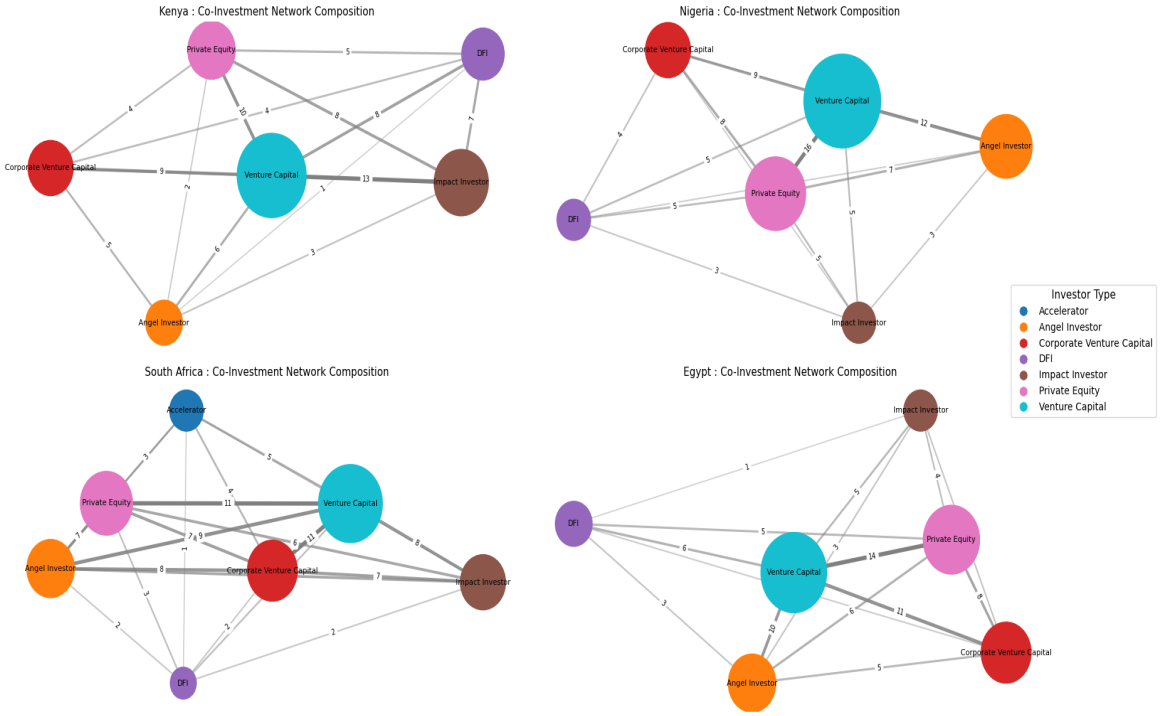


Figure 1. Co-investment network composition across the four African ecosystems

Note: Each node represents an investor type; node size reflects frequency of co-investment engagement, and edge thickness and values indicate the frequency of collaboration between investor types.

Source:: Authors' analysis of Crunchbase data

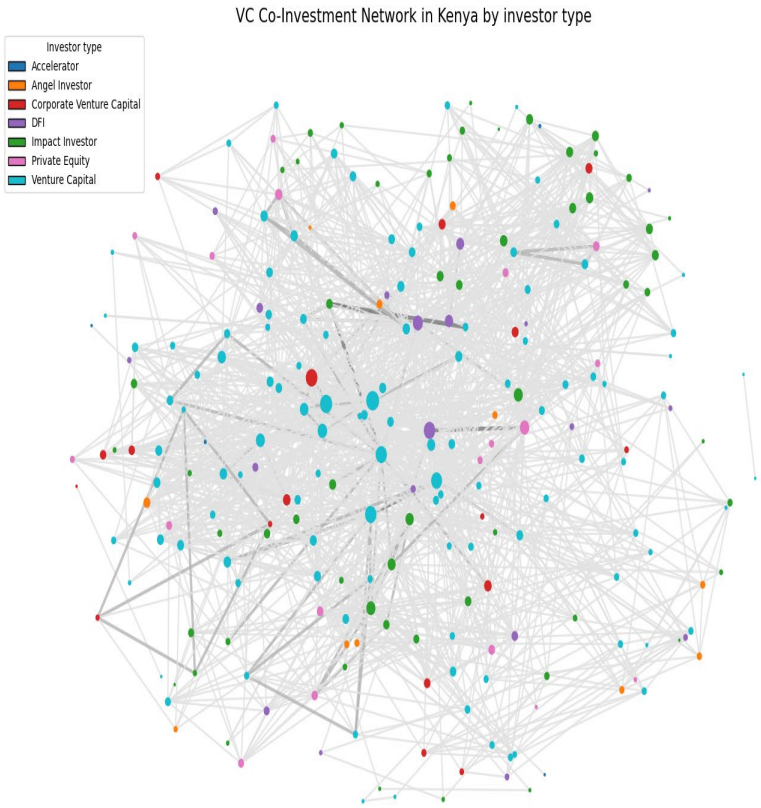


Figure 2. Co-investment network of the Kenyan venture capital ecosystem.

Note: Figure 2 shows a moderately connected network in which VC firms, impact investors, and DFIs are prominent, while PE, CVC, and angels are more peripheral, consistent with a blended-finance co-investment structure.

Source: Authors' analysis of Crunchbase data

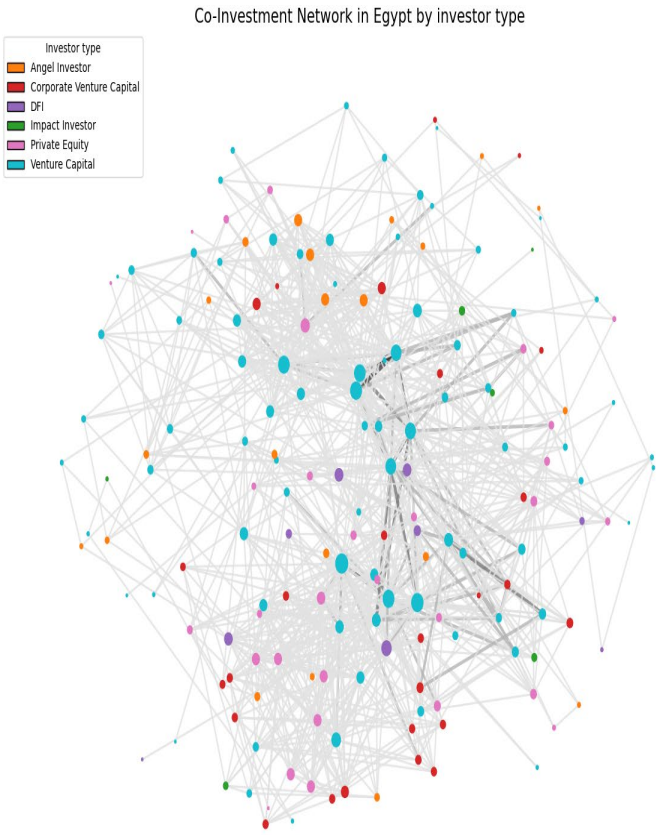


Figure 3. Co-investment network of the Egyptian venture capital ecosystem.

Note: Figure 3 shows a moderately connected, VC-centred network, with PE, angels, and CVC also present, while DFI and impact investors remain more peripheral, indicating a more commercially oriented co-investment structure.

Source: Authors' analysis of Crunchbase data

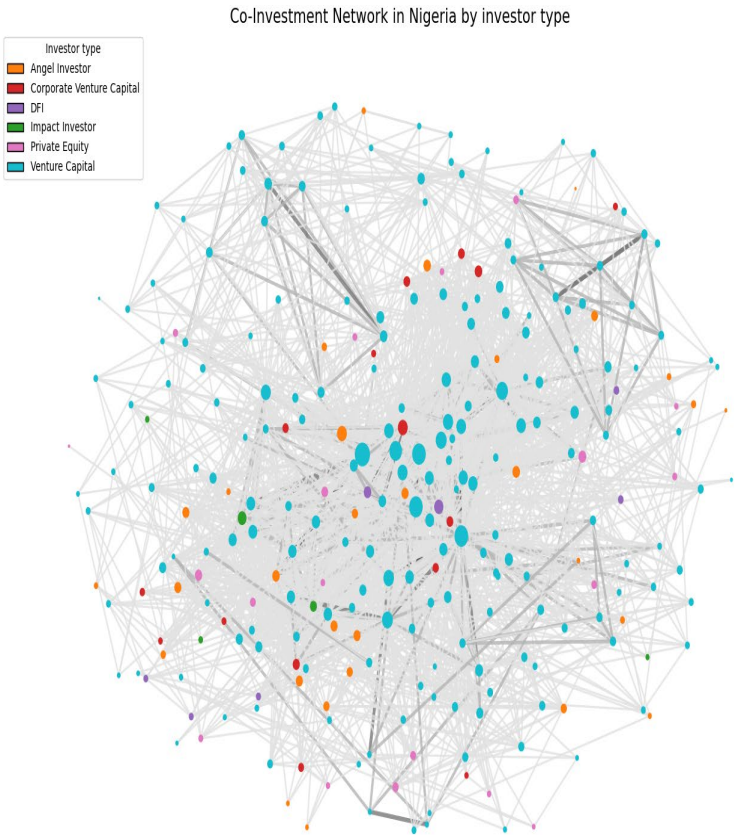


Figure 4. Co-investment network of the Nigerian venture capital ecosystem.
Note: The network is VC-centred, with strong participation from PE, angels, and CVC, while DFI and impact investors remain less central
Source: Authors' analysis of Crunchbase data



Figure 5. Co-investment network of the South African venture capital ecosystem.
Note: VC firms and angels occupy prominent positions, with PE, CVC, impact investors, and accelerators also embedded, indicating a relatively diversified co-investment structure.
Source: Authors' analysis of Crunchbase data

4.3. Investor composition across countries and stages

To assess whether the structural differences in Section 4.2 are accompanied by compositional variation, we examine investor type by country and investor type by funding stage. As noted in Section 3.7, because investors recur across rounds these statistics are interpreted with caution given the non-independence of observations.

4.3.1. Investor type by country

The chi-square statistic ($\chi^2 = 209.96$; df = 18; $p < 0.001$) summarises the magnitude of compositional differences in investor types across ecosystems (Table 8). Accelerator-backed deals are concentrated entirely in South Africa (seven of seven), a pattern distinct from the other six investor types, which appear across all four countries. The largest deviations show Nigeria over-representing VC (+70.05) and under-representing impact investors (−23.31); South Africa under-representing VC (−43.89) and over-representing angels (+30.93); and Kenya over-representing impact investors (+32.27) and DFIs (+6.69), consistent with a blended-finance configuration. These patterns describe country-level differences in the

observed data, consistent with Hypotheses 1 and 3, read descriptively given the non-independence of observations.

Table 8 . Investor-type distribution by country (observed and expected frequencies)

Chi-square: 209.96 | df: 18 | p-value: 1.01×10^{-34} | N: 1,447

Country	Accelerator	Angel	CVC	DFI	Impact	PE	VC
Egypt	0 (1.24)	21 (22.56)	19 (15.98)	16 (8.70)	6 (15.81)	26 (19.54)	169 (173.17)
Kenya	0 (1.47)	11 (26.59)	19 (18.85)	17 (10.26)	51 (18.64)	21 (23.03)	184 (204.16)
Nigeria	0 (2.61)	34 (47.31)	20 (33.52)	13 (18.25)	10 (33.15)	27 (40.97)	435 (363.18)
South Africa	7 (1.68)	61 (30.54)	32 (21.64)	3 (11.78)	22 (21.40)	36 (26.45)	187 (234.49)

Note: Observed (Expected) frequencies. Four of 28 cells (14.3 per cent) have expected frequency below 5 (all Accelerator) — within the 20 per cent validity threshold but read with caution. Observations not fully independent; interpreted descriptively. Largest deviations: Nigeria–VC (+70.05), South Africa–VC (−43.89), Kenya–Impact (+32.27).

Source: Authors' analysis of Crunchbase data.

4.3.2. Investor type by funding stage

The second test ($\chi^2 = 137.80$; df = 12; $p < 0.001$) summarises variation in participation across stages (Table 9). Angels are strongly concentrated at early stage (+37.39) and decline sharply across growth (−25.33) and late stages; VC is over-represented early (+36.80) and under-represented late (−20.31); CVC is under-represented early (−23.57) and peaks at growth (+16.95); and PE is concentrated at late stage. Notably, DFIs are under-represented at early stage (−14.91) and over-represented at growth (+11.11), consistent with Hypothesis 2's prediction that DFIs concentrate at intermediate rather than early stages, a pattern the rest of the paper develops as evidence of an early-stage coordination gap. The country-level patterns are consistent with Hypothesis 3 and the stage-based patterns with Hypothesis 2.

Table 9. Chi-square test of independence: investor type distribution by funding stage

Chi-square: 137.80 | **df:** 12 | ***p*-value**: 1.66×10^{-23} | N: 1,447

Investor type	Early stage	Growth stage	Late stage
Accelerator	3 (2.84)	3 (3.27)	1 (0.89)
Angel Investor	89 (51.61)	34 (59.33)	4 (16.06)
CVC	13 (36.57)	59 (42.05)	18 (11.38)
DFI	5 (19.91)	34 (22.89)	10 (6.20)
Impact Investor	22 (36.17)	49 (41.58)	18 (11.26)
Private Equity	23 (44.70)	58 (51.39)	29 (13.91)

Investor type	Early stage	Growth stage	Late stage
Venture Capital	433 (396.20)	439 (455.49)	103 (123.31)

Note: Observed (Expected) frequencies; text deviations are observed − expected (+ = over-represented, − = under-represented). Stages: early (pre-seed, seed), growth (Series A–B), late (Series C–D). Observations not fully independent; interpreted descriptively. Largest deviations: Early–Angel (+37.39), Early–VC (+36.80), Growth–Angel (−25.33), Early–CVC (−23.57), Early–PE (−21.70), Late–VC (−20.31).
Source: Authors' analysis of Crunchbase data.

4.4. Investor participation across TRL stages

Investor participation varies systematically with technological maturity across two ecosystem groups: an emerging group (Kenya, Egypt; Figure 6) and a mature group (Nigeria, South Africa; Figure 7). Both emerging ecosystems show VC dominance but with different supplementary bases. Kenya's early and growth stages are anchored by VC and impact investors, with CVC, DFI, and PE entering at growth; late-stage participation is distributed almost uniformly across VC, PE, impact investors, and DFIs, with no CVC. Egypt is structurally different: early-stage investment is stratified between VC, angels, and PE, with limited development capital; at growth, VC dominates alongside PE, CVC, DFI, and angels, with weak impact participation. In both cases, late-stage volumes collapse to fewer than 10 observations per stage.

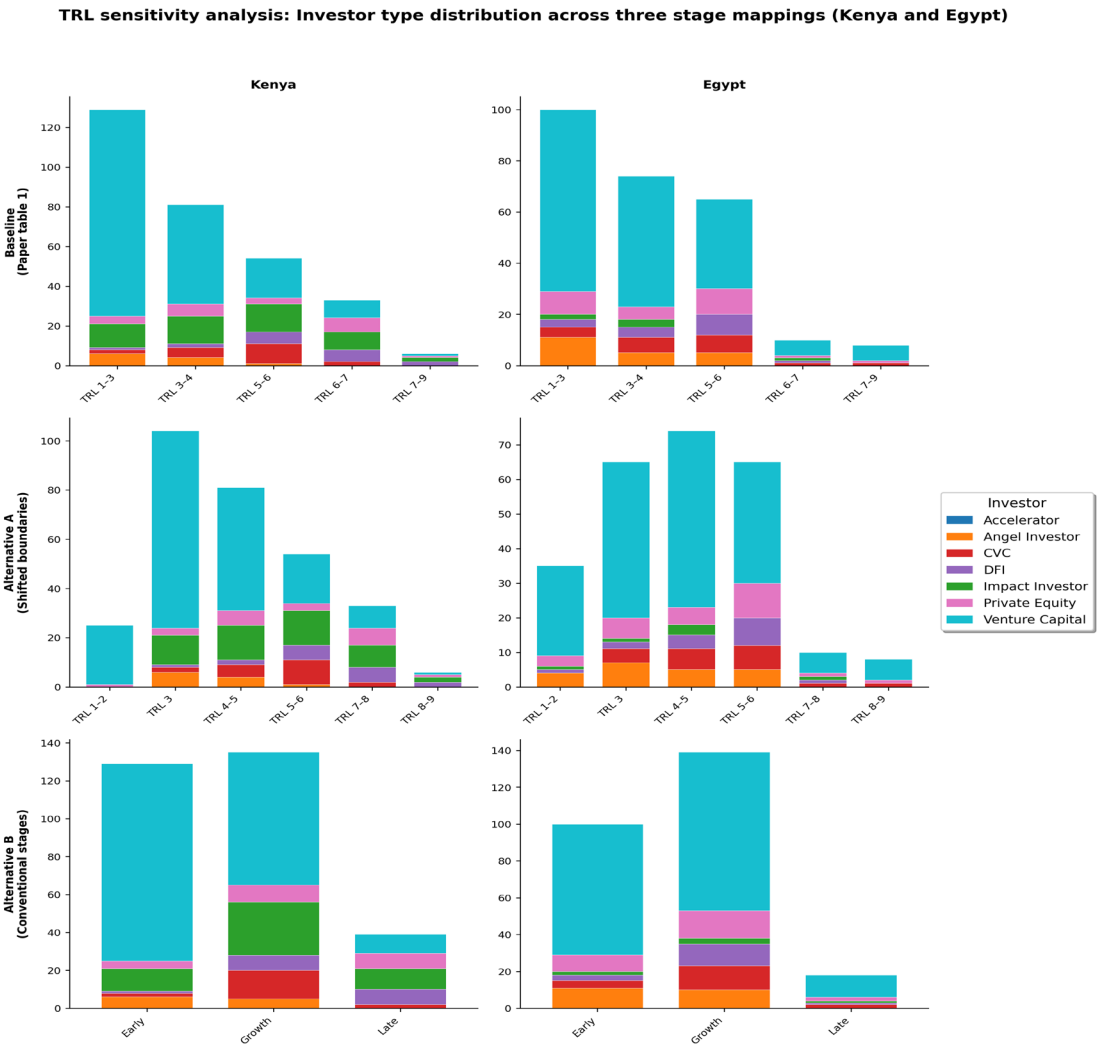


Figure 6. Comparative investor-type distribution by TRL (Kenya and Egypt).
Note: The x-axis represents the TRL range and the y-axis the number of investments; bars are segmented by investor type. Mapping definitions are given in Section 3.8.
Source: Authors' analysis of Crunchbase data

The mature ecosystems show greater diversity at every TRL and sustained late-stage volumes, but with distinct patterns. Nigeria's early stage is dominated by VC and angels, with low PE and almost no development capital; growth-stage activity broadens to include VC, PE, CVC, DFIs, and angels; late-stage rounds remain VC-led, with limited handoff to other investor types. South Africa exhibits the clearest staged-financing pattern: VC and angels anchor TRL 1–3 with no DFI presence; growth rounds diversify into VC, PE, CVC, and impact investors; and late-stage rounds are dominated by VC, PE, and CVC.

These findings provide partial support for Hypothesis 2. Stratification is clearly observed in mature ecosystems, particularly in South Africa, with an early-angel, mid-VC, late-PE/CVC handoff. At the same time, Nigeria shows growth-stage diversification without a clear late-stage handoff. In the emerging ecosystems, stratification reflects different supplementary bases (development-oriented in Kenya, commercial-private in Egypt) with VC carrying the lifecycle. A consistent pattern in line with Hypothesis 2 holds across all four cases: DFI participation at the earliest TRLs is limited, notably absent in South Africa's TRL 1–3, with DFIs concentrating at intermediate stages, taken up in Section 5.

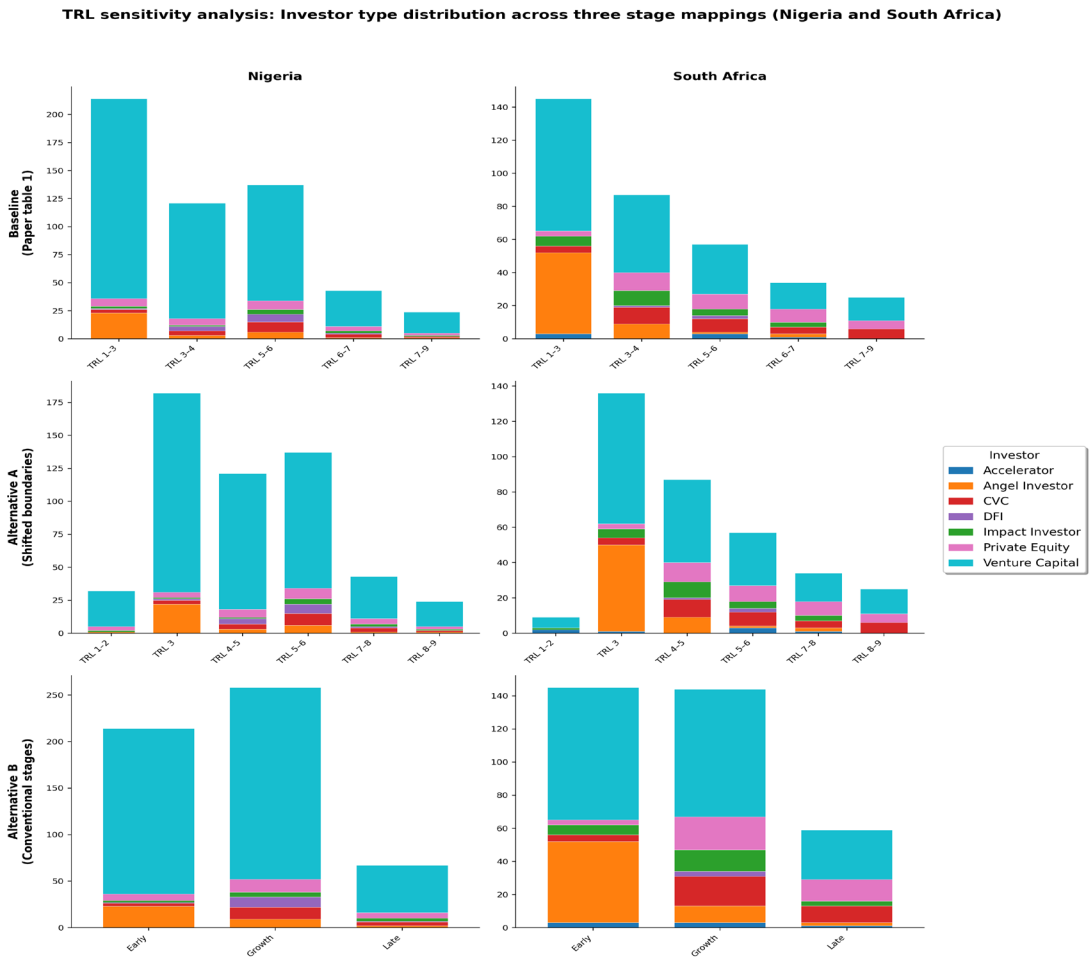


Figure 7. Comparative investor-type distribution by TRL (Nigeria, South Africa).

Note: The x-axis represents the TRL range and the y-axis the number of investments; bars are segmented by investor type. Mapping definitions are given in Section 3.8.
Source: Authors' analysis of Crunchbase data

4.4.1. Robustness of TRL-based findings

The stage-based pattern reported above does not depend on the TRL mapping used. The association between investor type and stage remains significant under all three specifications, with Cramér's V ranging from 0.162 to 0.218 (Table 10). The substantive patterns are equally stable: declining VC share from early to late stages, angel concentration at the early stage, higher PE and CVC shares at late stages, and below-average DFI participation at the earliest stages each hold under every mapping (Table 11).

At country level, Kenya and South Africa display the strongest compositional patterning across mappings, while Nigeria shows weaker but persistent stage differentiation. Egypt shows comparatively limited stage-based differentiation under all three specifications, consistent with a structurally distinct ecosystem in which VC dominates the lifecycle without meaningful handoff to other investor types. Full country-level test statistics under each mapping are reported in Appendix E (Table E1).

Table 10 . Investor type × stage association under three TRL mappings

Mapping	χ^2	df	p-value	N	Cramér's V
Baseline	166.36	24	2.85×10^{-23}	1,447	0.1695
Alt A (Shifted)	190.09	30	3.48×10^{-25}	1,447	0.1621
Alt B (Conventional)	137.80	12	1.66×10^{-23}	1,447	0.2182

Note: All investor types retained. Observations not fully independent; interpreted descriptively.
Source: Authors' analysis of Crunchbase data

Table 11. Pattern robustness across TRL mappings

Pattern	Baseline	Alt A (shifted)	Alt B (conventional)
VC share declines early → late	Yes	Yes	Yes
Angels concentrated at early stages	Yes	Yes	Yes
PE share higher at late stages	Yes	Yes	Yes
CVC share higher at late stages	Yes	Yes	Yes
DFI below average at earliest stage	Yes	Yes	Yes

Note: All investor types retained. Observations not fully independent; interpreted descriptively.
Source: Authors' analysis of Crunchbase data

4.5. Qualitative triangulation: interview evidence on co-investment dynamics

Across interviews, participants consistently described co-investment as structured by mandate complementarity rather than homogeneous peer matching. Syndication reflects not only capital considerations but the combination of differentiated capabilities. As one VC investor explained, "*You don't syndicate just for capital, you bring different capabilities to the table*" (P2, VC investor, Kenya). Partner selection is shaped by what each actor contributes beyond funding: "We look for investors who bring what we lack; if we bring governance capacity, we want someone with local distribution networks or regulatory relationships" (P6, VC investor, Kenya). This provides qualitative evidence consistent with Hypothesis 1 and clarifies the mechanism underlying the compositional heterogeneity observed in Sections 4.2–4.3.

On lifecycle dynamics, interviewees indicated that investor participation is conditioned by technological and market uncertainty. Early-stage ventures require risk-tolerant investors providing hands-on support,

while more institutionalised investors enter as ventures mature. As one VC investor explained, "*At the early stage, you need people comfortable with uncertainty; later, it becomes about scaling*" (P14, VC investor, Nigeria). Notably, participants explained DFI concentration at intermediate rather than early stages: "*At the early stage, angels and smaller funds set things up. DFIs are more effective once there is a co-investment structure they can anchor and help scale*" (P5, VC investor, Kenya). This suggests that DFI positioning reflects deliberate sequencing around validated ventures rather than an absence of an early-stage mandate. These patterns align with Hypothesis 2.

Interview evidence from Kenya and Nigeria also highlights cross-country variation in ecosystem logics, with participants pointing to differing coordination structures consistent with the network patterns in Sections 4.2–4.3. One participant described the consequences of a key investor withdrawing: "*When a major VC pulled back, three deals collapsed, not because of the capital gap, but because no one else could hold the syndicate together*" (P18, VC investor, Nigeria). This illustrates how bridging investors function as coordination infrastructure, consistent with Hypothesis 3.

5. Discussion

The research examines co-investment networks in four venture capital ecosystems in Africa to establish if the divergence of the networks from what has been noted in mature markets demonstrates an ecosystem's incompleteness or a different coordination strategy. The findings support a networked coordination interpretation of co-investment rather than one based solely on ecosystem incompleteness. The ecosystems can be seen as nascent rather than incomplete due to the presence of a variety of types of investors who combine development and business rationale.

5.1. Institutional heterogeneity as a coordination response to fragmented intermediation

VC development research that has been done in the context of institutional constraints and has shown that intermediation in the emerging market is spread across three dimensions: capital, relational access for deal referrals and exit opportunities, and governance and knowledge resources (Ahlstrom & Bruton, 2006; Da Rin et al., 2006; Hochberg et al., 2007; Lerner & Schoar, 2005). There is no one type of investor who provides the whole package of resources that are typical of intermediary function in mature markets. Compositional analysis (Tables 4, 6, 8) shows that the resource bundle is acquired by startups via a coalition of investors that includes VC firms, DFIs, impact investors, private equity, corporate VCs, and angels. Thus, heterogeneity should not be seen as a problem but as a solution that allows acquiring complementary resources in the environment of fragmented intermediation.

This implies that the focus has to be changed from institutional voids to coordination challenges. Intermediation is not lacking, it is fragmented between actors that have different mandates, timeframes, and modes of value addition. According to the interviewees, the partner selection process is based on complementarity rather than capital gap-filling (P2, P6). Mature-market syndication is often examined as a selection and certification process that happens among professional VCs (Lerner, 1994; Manigart et al., 2002) while syndication pattern in Africa implies actors with different mandates establishing complementarities around ventures. Coordination is possible due to network connections as networks help with the flow of capital and information during syndication (Rabi & Petty, 2026). However, coordination is also dependent on the structure of co-investments, not only on capital availability. Yet, the design of the syndication does not mean that heterogeneous coalitions perform better than homogeneous ones.

5.2. Lifecycle stratification and the position of development finance

Investor participation is stratified by stage and technology maturity (Tables 6, 9; Figure 6) in support of Hypothesis 2 and the staged financing model (Gompers, 1995; Hellmann & Thiele, 2015; Sahlman, 1990). Angels are more present at early stages, while private equity and corporate venture capital enter at later stages of maturation. Sensitivity checks suggest that the transition observed is not an artefact of TRL classification.

Development finance institutions (DFIs) are underrepresented at early stages and present primarily at intermediate stages (Table 9; Figure 6). This is supported by compositional, TRL, and interview evidence: "DFIs are more effective once there is a co-investment structure they can anchor and help scale" (P5). The distinction between sequencing and mandate explanations remains unresolvable on the basis of

observational cross-sectional data; however, qualitative evidence suggests sequencing as the mechanism, even though longitudinal evidence is needed to resolve it.

Impact investors partially mitigate the early-stage development-finance gap. Their presence across all four ecosystems, particularly in Kenya, suggests that development-oriented capital can enter earlier through investors with more flexible mandates than DFIs. However, impact investors generally operate with smaller tickets and more limited governance capacity. Similar evidence from Chile shows that impact capital also tends to concentrate around more mature ventures (Viglialoro et al., 2024), suggesting that barriers to early-stage participation may persist even among more flexible development-oriented investors.

Overall, early-stage finance is therefore constrained rather than absent. VC firms and angels dominate, while impact investors provide supplementary development-oriented capital. DFIs remain comparatively underrepresented at the stages where their scale and governance capacity could potentially be most additional, although this study does not directly measure additionality. The result is a persistent early-stage coordination gap.

5.3. Cross-country structure and ecosystem logics

The structure demonstrates variability at the descriptive level – Nigeria and South Africa show greater density, while Kenya and South Africa show higher modularity (see Table 7). However, no difference between two countries in terms of density is statistically significant ($p > 0.8$ for all comparisons). On the other hand, there are stronger differences in terms of composition – impact investors in Kenya, angels in South Africa, and private equity in Egypt.

The above results suggest different institutional configurations of coordination. Since the interviews cover only Kenya and Nigeria, any claims about South Africa and Egypt must be based on the literature review (AVCA, 2023, 2024, 2025; Partech, 2025) and focus more on the descriptive and network evidence than qualitative mechanisms testing. In the case of Kenya, the structure is compatible with development-oriented sectors, legacy of M-Pesa, and hybrid-mandate funds. The venture capital-dominated structure of Egypt is compatible with commercially-oriented environment, lower DFI involvement, and weak blended finance structure. The diversified structure of South Africa can be explained through its domestic investor base, exit infrastructure, and accelerators. Finally, the dense commercial structure of Nigeria can be attributed to its domestic size, fintech-driven deal flow, and dominance of pan-African venture capital.

It seems that bridging investors also facilitate coordination of these structures (Sorenson & Stuart, 2001; Hochberg et al., 2007). For example, one interviewee mentioned how three deals failed, since a key venture capital player withdrew not due to lack of funds, but inability to coordinate syndicate (P18). It implies that some investors not only bring in the money, but relational coordination.

5.4. Theoretical and practical implications

The data suggest that coordination capacity varies from stage to stage. In cases where financing-stage handoffs are built into the process, i.e., from angel investors early on through venture capital mid-stage and private equity/corporate venture capital late-stage, the resulting structure appears to provide greater capacity for assembling the required resource bundle. Where one investor group dominates and such handoffs are limited, the structure may provide fewer opportunities for complementary resource coordination.

The deviation from mature markets is therefore one of investor variety and coordination rather than of developmental stage per se. Mature markets have syndications that are commercial; African markets are a mix of both commercial and development players. The Technology Readiness Level (TRL) concept is a useful maturity heuristic for measuring investor sequence where stage definitions are not being used consistently. Since the TRL of startups cannot be measured but is based on financing stage, it should be seen as a heuristic measure.

Policy makers need to take account of both the volume of capital as well as the relational architecture coordinating various investor types for ecosystem development. Additionality measures in the case of DFIs must take account of network positions, being at intermediate stages around validated ventures can lead to scaling, but early anchoring of syndication can correct coordination problems in the markets that have the greatest gaps..

5.5. Limitations

The sample includes only startups which have gone through several funding rounds, thus inducing survivorship bias. The coverage varies by country, and differences may arise due to data scarcity. There is variation in network sizes and modularity measures are affected by this variation. Chi-square statistics use non-independent participation of investors and are used descriptively. The TRL mapping was performed heuristically rather than empirically. The qualitative research is limited to Kenya and Nigeria, without any parallel insights on South Africa and Egypt. Cross-sectional design allows description and comparison but not causation. Data for 2006-2024 capture significant market changes with a majority of fintech startups in the sample. Future research needs to re-estimate the data for different time periods and industries, use longitudinal data, do centrality analysis, expand qualitative research scope, and validate TRL at the startup level.

6. Conclusion

This study shows that the four African venture capital ecosystems examined here are better understood not as incomplete versions of mature markets but as distinct coordination systems in which no single investor type supplies the full resource bundle that startups require. Co-investment coalitions are the mechanism through which this bundle, follow-on capital, governance, network access, and know-how, is assembled across investors with complementary mandates. Three findings support this interpretation.

First, co-investment syndicates are institutionally heterogeneous, consistent with an adaptive response to fragmented intermediation rather than a transitional feature of nascent ecosystems. VC firms coordinate across DFIs, impact investors, PE, corporate investors, and angels through mandate complementarity, and coalition composition varies systematically across ecosystems, indicating that investor functions are shaped by local institutional conditions rather than universal financial logic. The contrast with mature markets lies in investor diversity: African ecosystems blend commercial and developmental logics, whereas mature markets are predominantly VC-centric.

Second, investor participation is stratified by technological maturity. Angels and VC firms concentrate in the early stages; PE and corporate investors enter later; and impact investors provide supplementary development-oriented capital where DFIs are absent. DFIs concentrate on intermediate rather than early stages, suggesting that development capital sequences around validated co-investment structures rather than leading early-stage financing. This points to a persistent coordination gap: the investor type with the capital scale and governance capacity most additive at the earliest stage appears systematically absent from where market failures are most acute.

Third, network structures vary descriptively across ecosystems in density, clustering, and modularity, though no pairwise density difference reaches statistical significance. In more modular systems, bridging actors are critical for connecting fragmented investor clusters, and their withdrawal can disrupt capital flows independently of funding availability, suggesting that network position may function as a strategic asset alongside capital, although this study does not link network position to firm-level outcomes.

Together, these findings support a networked coordination perspective as an alternative to assumptions of mature-market convergence. Strengthening African VC ecosystems requires attention to relational infrastructure, the connectivity among heterogeneous actors, not only to capital supply. Increasing the number of actors without improving network coordination capacity is unlikely to resolve the identified structural bottlenecks. For DFIs, additionality assessments should focus on positioning within co-investment networks at the earliest stages rather than on capital deployed at intermediate stages where co-investment structures are already in place.

Future research should examine the dynamic evolution of co-investment networks, linking changes in network structure to firm-level outcomes and ecosystem performance. Identifying bridging actors through centrality analysis, extending qualitative coverage to South Africa and Egypt, and testing whether the coordination mechanisms observed here generalise across African ecosystems are the most immediate next steps. Understanding how coordination capacity emerges, persists, or breaks down over time is essential for explaining not only how capital is allocated but how innovation systems scale under institutional constraint.

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Appendix A. *TRL mapping and investor participation by country*

This appendix presents the operational mapping between Technology Readiness Levels (TRLs), startup funding stages, and dominant investor participation patterns across Kenya, Nigeria, South Africa, and Egypt. The mapping supports the descriptive and network analyses in Section 3 by aligning funding stages with comparable phases of technological development.

Table A1. TRL mapping and investor participation by country

TRL Stage	Technology Development Stage	Kenya	Nigeria	South Africa	Egypt
TRL 1–3	Basic research, early concept	Impact	Impact, PE, VC	Accelerator, Impact, PE, VC	Angel, Impact, PE, VC
TRL 3–4	Prototype, validation	Angel, CVC, Impact, PE, VC	Angel, CVC, Impact, PE, VC	Angel, CVC, Impact, PE, Accelerator, Corporate, VC	Angel, CVC, Impact, PE, Corporate, VC
TRL 5–6	MVP, early market	Angel, CVC, Impact, PE, DFI, VC	VC, DFI, CVC, Impact	Angel, CVC, Impact, PE, Accelerator, DFI, Corporate, VC	CVC, Impact, PE, Corporate, VC
TRL 6–7	Pilot, early traction	CVC, Impact, PE, VC	Corporate, CVC, DFI, Impact, PE, VC	CVC, Impact, PE, DFI, Accelerator, Corporate, VC	CVC, Impact, PE, DFI, Corporate, VC
TRL 7–9	Commercialisation	CVC, Impact, PE, VC	CVC, DFI, PE, Impact	CVC, Impact, PE, DFI, Accelerator, Corporate, VC	CVC, VC

Source: Authors' compilation. Note: This appendix presents an illustrative mapping of investor participation by stage, reconciled with the empirical data in Tables 4, 6 and 8; accelerators are shown only for South Africa, the sole ecosystem with recorded accelerator participation (n = 7).

Appendix B. *Variable Definitions*

This appendix defines the key variables used in the analyses and clarifies how they are constructed.

Startup and Investment Characteristics

- **Country:** A categorical variable indicating the country in which the funded startup operates (Nigeria, Kenya, South Africa, Egypt).

- **Funding Stage:** A categorical variable capturing startup maturity at the time of investment (Pre-Seed, Seed, Series A, Series B, Series C, Series D+).

- **Startup Technology Readiness:** An ordinal variable based on the TRL framework, ranging from early-stage R&D (TRL 1–3) to full commercial deployment (TRL 7–9).

- **Investor Type:** A categorical variable identifying investors by institutional profile (VC, CVC, DFI, private equity, impact investor, accelerator, angel investor).

- **Syndicate Size:** The total number of investors participating in a funding round, indicating the scale of collaborative investment activity.

Co-Investment and Network Structure Variables

- **Co-Investment Frequency:** A continuous measure capturing the number of startups in which two investors jointly participated, proxying historical collaboration and relational embeddedness.

All variables are constructed consistently across countries and funding stages to ensure comparability in the network analyses.

Appendix C. Investor type definitions

This appendix defines the investor types used in the classification of co-investment network participants. Definitions draw on established literature and are applied consistently across all four country ecosystems. The empirical analysis uses seven mutually exclusive investor-type categories: venture capital (VC), corporate venture capital (CVC), development finance institutions (DFIs), private equity (PE), impact investors, accelerators, and angel investors. These seven categories are used throughout Tables 4, 6, 8 and 9 and in all network analyses.

Venture Capital (VC): Firms providing equity financing to high-growth startups, typically navigating the 'valley of death' between early development and commercial viability. Experienced VCs often target early-stage, high-growth sectors (Gupta & Sapienza, 1992; Kenney, 2000).

Impact Investors: Investors seeking both social and financial returns, targeting underserved communities and assessing social missions alongside profitability (Agrawal & Hockerts, 2021; Höchstädter & Scheck, 2015).

Development Finance Institutions (DFIs): State-backed entities that address financing gaps in developing markets, offering long-term loans and risk guarantees, often catalysing private capital through blended finance (Leon, 2025; MFF, 2024).

Private Equity (PE): Firms that acquire and optimise established companies for profit, managing institutional funds with longer horizons and more risk aversion than VCs (Kaplan & Strömberg, 2009).

Accelerators: Programmes supporting early-stage, high-risk startups with mentorship and training for small equity stakes, aimed at boosting survival and scalability (Cánovas-Saiz et al., 2020; Cohen & Hochberg, 2014).

Corporate Venture Capital (CVC): Minority equity investments by corporations for strategic objectives such as innovation access and market intelligence, though potentially introducing risks such as intellectual property conflicts (Katila et al., 2008; Weniger & Jarchow, 2023).

Angel Investors: Wealthy individuals offering early-stage capital with mentorship, often investing locally in high-risk, high-potential ventures (Mason & Harrison, 2008).

Appendix D. *Interview participant details*

This appendix presents details of the 23 semi-structured interviews conducted for qualitative triangulation. Participants were selected through purposive sampling and included venture capital investors, startup founders, and executives involved in VC-backed firms across Kenya and Nigeria. Interviews were conducted between April and September 2025. All participants are anonymised.

Table D1. Interview participant details

ID	Role	Organisation type	Participant category	Country	Interview mode	Date
P1	Founder and Managing Partner	VC firm	VC investor	Kenya	In person	April 2025
P2	Partner	VC firm	VC investor	Kenya	In person	April 2025
P3	Director, Portfolio and Strategy	VC firm	VC investor	Kenya	In person	April 2025
P4	Partner	VC firm	VC investor	Kenya	In person	April 2025
P5	Principal	VC firm	VC investor	Kenya	In person	May 2025
P6	General Partner	VC firm	VC investor	Kenya	In person	May 2025
P7	Managing Director	VC firm	VC investor	Kenya	In person	May 2025
P8	Founder	Startup	Startup founder	Kenya	In person	April 2025
P9	Director	Startup	Startup executive	Kenya	In person	April 2025
P10	Founder	Startup	Startup founder	Kenya	In person	May 2025
P11	Founder	Startup	Startup founder	Kenya	In person	May 2025
P12	Director	Startup	Startup executive	Kenya	In person	May 2025
P13	Founder	Startup	Startup founder	Kenya	In person	May 2025
P14	Principal	VC firm	VC investor	Nigeria	In person	July 2025
P15	Principal	VC firm	VC investor	Nigeria	In person	July 2025

ID	Role	Organisation type	Participant category	Country	Interview mode	Date
P16	Principal	VC firm	VC investor	Nigeria	Online	August 2025
P17	Investment Principal	VC firm	VC investor	Nigeria	Online	September 2025
P18	General Partner	VC firm	VC investor	Nigeria	Online	September 2025
P19	Founder	Startup	Startup founder	Nigeria	Online	July 2025
P20	Founder	Startup	Startup founder	Nigeria	Online	July 2025
P21	Founder	Startup	Startup founder	Nigeria	Online	July 2025
P22	Senior Associate	Startup	Startup executive	Nigeria	In person	July 2025
P23	CEO	Startup	Startup executive	Nigeria	Online	July 2025

Note.: All participants anonymised; roles and organisation types reflect positions at the time of interview. Interviews were conducted in person or online. Categories: VC investors (n = 12), startup founders (n = 7), startup executives (n = 4).

Source: Authors' compilation

Appendix E. *TRL sensitivity analysis: supporting tables*

This appendix provides supporting detail for the robustness analysis reported in Section 4.4.1.

Table E1. Country-level chi-square tests of investor type × stage under three TRL mappings

Mapping	Country	χ^2	p-value	Cramér's V
Baseline	Kenya	92.71	2.48×10^{-11}	0.277
Baseline	Nigeria	37.22	1.10×10^{-2}	0.131
Baseline	South Africa	91.41	8.41×10^{-10}	0.256
Baseline	Egypt	22.04	0.338	0.146
Alternative A	Kenya	97.55	1.62×10^{-10}	0.254
Alternative A	Nigeria	44.69	9.06×10^{-3}	0.129
Alternative A	South Africa	118.13	2.10×10^{-12}	0.261
Alternative A	Egypt	23.49	0.549	0.135
Alternative B	Kenya	72.09	1.75×10^{-11}	0.345
Alternative B	Nigeria	30.89	6.13×10^{-4}	0.169
Alternative B	South Africa	76.40	2.00×10^{-11}	0.331
Alternative B	Egypt	10.02	0.439	0.140

Note: All investor types present in each country's data are retained. Accelerator appears only in South Africa (n = 7); Egypt, Kenya, and Nigeria record zero Accelerator observations. Due to small cell sizes at the country level, a substantial proportion of cells have expected frequencies below 5; results are interpreted descriptively as indicators of compositional patterning rather than as confirmatory tests.

Source: Authors' analysis of Crunchbase data



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