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FinTech and SMEs financing: A systematic literature review and bibliometric analysis

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ABSTRACT

Small and medium-sized enterprises (SMEs) face obstacles in raising capital and accessing financial services due to information asymmetry, high transaction costs and lack of collateral. FinTech developments have made gathering and sharing information easier, changed how funds are mobilized and allocated, and increased capital-raising activities. This paper conducts a systematic literature review on FinTech and SME financing for the period 2008–2022. So far there are unstructured and separate publications on this topic. Therefore, there is a need to consolidate the empirical research and their findings on the effectiveness of FinTech in meeting SMEs' financing needs. The bibliometric findings show that few studies on FinTech and SME financing are empirical in nature. These empirical studies surged a decade later after FinTech 3.0 started in 2008, with the majority of them using quantitative methods based on data from surveys and FinTech platforms. Furthermore, emerging alternative digital financing to SMEs have attracted more empirical studies than those on FinTech and bank lending to SMEs. In terms of publications, China is dominating, followed by the United States. The content analysis shows that FinTech has increased the ability of financial and non-financial institutions to collect and process accurate information about SMEs, thus reducing information asymmetry and transaction costs. FinTech has also increased the speed and quality of the lending cycle, from establishing an SME pipeline, collecting and processing information, to loan screening, monitoring and repayment. Finally, the paper presents research gaps and areas for future studies, challenges and policy recommendations on this novel subject.

1. Introduction

Financial technology (FinTech[1]) is shaping the financial sector by changing traditional business models with increased intermediated and non-intermediated financial services and products. The credit market landscape is becoming competitive with traditional banks, alternative financiers, and new entrants using FinTech effectively. FinTech developments have made gathering and sharing information more accessible, changed how funds are mobilized and allocated, and increased capital-raising activities (Bank for International Settlements, 2018; Thakor, 2020). Small and medium-sized enterprises (SMEs) in developing and emerging countries are characterised by information opacity, and lack of financial statements and hard information for banks to assess their creditworthiness. Thus, SMEs face obstacles in raising capital and accessing financial services primarily because of information asymmetry, high transaction costs, and lack of collateral (Stiglitz & Weiss, 1981). FinTech can help lenders mitigate credit risks associated with information asymmetry and lack of collateral and reduce lenders' cost and time to collect information and assess borrowers (Larios-Hernandez, 2017). Internet financial services as web-based banking platforms allow banks to collect and process SMEs' information as they do online banking operations, regardless of time and geographical location (Mushtaq, Gull, & Usman, 2021). Blockchain-embedded lending models with distributed digital ledger and smart contracts address SMEs' problem of information asymmetry and credit rationing (Wang, Lin, & Luo, 2019). Blockchain also offers a new means of financing for SMEs and entrepreneurs through token sales or initial coin offerings (ICOs) (Adhami, Giudici, & Martinazzi, 2018). Big data analytics and artificial intelligence (AI) are changing credit scoring approaches, allowing banks and FinTech lenders to assess SMEs and other borrowers with limited

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[1] The Financial Stability Board (FSB) defines FinTech as "*technologically enabled financial innovation that could result in new business models, applications, processes, or products with an associated material effect on financial markets and institutions and the provision of financial services*" (Bank for International Settlements, 2018, p. 8).

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Table 1
Innovative financial services driven by emerging technologies.

	Emerging technologies in financial services				
	FinTech			**InsurTech**	**RegTech**
Impact on	***Financial inclusion***	***Financing***	***Exchange market***	***Insurance***	***Financial regulations***
Financial services	Payments, clearing, and settlement services	Credit, deposits, and capital-raising services	Investment management services	Risk and insurance services	Prudential guiding and supervision services
Financial products	Retail (mobile money, P2P transfers, and digital currencies) Wholesale (value transfer networks, FX wholesale, and digital exchange platforms), traditional bank transfers	Crowd-funding, P2P lending (marketplace lending), traditional banks' products, mobile banks and credit scoring,	High-frequency trading, copy trading, e-trading and robo-advice	Link to mobile devices, big data, risk pricing and smart contracts	Regulatory intelligence, transaction monitoring and reporting, identity management and risk management
Examples	*Retail products:* M-Pesa, Alipay, *Digital currencies:* Bitcoin, Ethereum, Dash, Monero, Litecoin, etc.	*Crowd-funding:* GoFund, Crowdcube, Kickstarter, etc. *P2P Lending:* LendingClub, Funding Circle, etc.	*e-trading solutions:* Sierra eTrader, Kx for Flow, etc. *Robo advisors:* Betterment, Wealthfront, etc.	*InsurTech companies:* Lazarus AI, Relay, Spot, Halos, Sorcero, etc.	*Regulatory intelligence:* Alessa, Acarda GmbH, etc.
Underlying technologies	Mobile technology, blockchain, artificial intelligence, cloud computing, internet of things, big data and analytics, cybersecurity, and general ICT infrastructure				

Source: (Bank for International Settlements, 2018; Da Silva, 2018; Thakor, 2020).

financial history using non-traditional data such as digital footprints. Machine learning, deep learning, and big data have improved SMEs' credit risk assessment for online supply chain financing and trade credits (Shao, Lou, Wang, Mao, & Ye, 2022; Song, Li, & Yu, 2021). In addition, mobile money and mobile banking increase SMEs' creditworthiness (Lorenz & Pommet, 2021; Mdoe & Kinyanjui, 2018). Furthermore, alternative financing schemes such as crowd-funding, crowd-lending, crowd-investing, and marketplace (P2P) lending are another vehicle for bridging the SMEs' finance gap with debt and equity financing (Xiang, Zhang, & Worthington, 2021). Thus, this paper aims to gain insights from the empirical literature on FinTech and SME financing by delving into the current state, findings, gaps, and challenges, as well as the recommended policies and future studies. FinTech and SME financing is an essential research topic in development financing, particularly in developing countries where SMEs are considered engines for social and economic development.

Plenty of papers are appraising, analysing, and reviewing the potential of FinTech in literature. However, these papers focus on different aspects, including FinTech and the future of banking, lending, digital payment and systems, and financial markets (Agarwal, 2020; Hanafizadeh & Amin, 2023; Ivashchenko et al., 2018; Sangwan, Harshita, Prakash, & Singh, 2020; Thakor, 2020), the evolution and future of FinTech (Arner, Barberis, & Buckley, 2015; Boot, 2017; Boot, Hoffmann, Laeven, & Ratnovski, 2021; Das, 2019; Navaretti, Calzolari, Mansilla-Fernandez, & Pozzolo, 2018), implications of FinTech on bank supervision and regulations (Bank for International Settlements, 2018; Sangwan et al., 2020), alternative financing (Drummer, Feuerriegel, & Neumann, 2017; Farag & Johan, 2021; Temelkov & Samonikov, 2018), and adoption, risks and benefits of FinTech (Da Silva, 2018; Frost, 2020). Furthermore, some papers have systematically reviewed the literature on SME financing but have yet to discuss the impact of FinTech. For example, Kersten, Harms, Liket, and Maas (2017) conducted a systematic review of studies that used an experimental or quasi-experimental design to evaluate finance programs for SMEs in low- and middle-income countries. Bartolacci, Caputo, and Soverchia (2020) systematically reviewed the literature focusing on SMEs' sustainability and financial performance from 1999 to 2018. Using a systematic approach, Rao, Kumar, Chavan, and Lim (2021) reviewed 280 papers on SME financing published in the top five SME journals from 1986 to 2020. Other systematic review studies on FinTech (Barroso & Laborda, 2022; Firmansyah, Masri, Anshari, & Besar, 2022; Jain, Kumar, Sood, Grima, & Rupeika-Apoga, 2023; Suryono, Budi, & Purwandari, 2020; Tello-Gamarra, Campos-Teixeira, Longaray, Reis, & Hernani-Merino, 2022) focus on adoption, trends, institutions, collaboration, regulation, challenges and risks without discussing their impact on SME finance. To our knowledge, no systematic literature review focuses on FinTech and SME financing. This novel topic is an essential research area in development financing, particularly in developing countries where SMEs are considered engines for social and economic development.

Therefore, we fill this gap by systematically reviewing FinTech and SME financing literature from 2008 to 2022. The review addresses four research questions: (*RQ1*) What are the empirical publication trends on FinTech and SME financing? (*RQ2*) What are the findings from the empirical literature on FinTech and SME financing? (*RQ3*) What are the gaps and future research areas on FinTech and SME financing? (*RQ4*) What are the challenges and policy recommendations to promote FinTech and SME financing, particularly in developing and emerging countries? In answering these questions, this systematic review contributes to the literature in several ways: (i) It helps to consolidate the empirical research and their findings on the effectiveness of FinTech in meeting SMEs' financing needs, highlighting research gaps and potential challenges. So far, there are unstructured and separate publications on this topic. As research on FinTech and SME financing is surging, there is a need to create a structured body of knowledge through a systematic literature review. (ii) It shows researchers and scholars the relevant areas for future research in the emergent FinTech and SME financing field. So far, no systematic review work has assessed the progress on this topic and illustrated potential areas for future research. (iii) It consolidates policy recommendations for policymakers and practitioners who play a vital role in supporting SMEs that often face challenges in accessing traditional financing options to explore alternative and inclusive financing solutions driven by FinTech.

The remainder of the study is organised as follows. Section 2 describes how FinTech is evolving in developing, emerging, and developed countries, while Section 3 discusses the methodology used for the review. Sections 4 and 5 present results from the bibliometric and content analysis. Section 6 discusses research gaps and areas of future research on FinTech and SME finance. Section 7 presents the challenges and policy recommendations on FinTech and SME finance. Finally, Section 8 offers concluding remarks.

2. FinTech revolution and growth in various financial markets

FinTech is changing the financial market landscape and how financial services and products are designed and offered. Arner et al. (2015) presented the FinTech journey from its inception in the 1860s and how it

evolved in three different stages: (i) *FinTech 1.0* (1866–1967) enabled fast transfers of financial services after the installation of Trans-Atlantic cable and telegraphs. (ii) *FinTech 2.0* (1967–2008), which includes SWIFT, ATMs, electronic payments, settlements and banking, improved the delivery of conventional financial services and products. (iii) *FinTech 3.0* (2008–present), comprising innovative financial services and products (see Table 1), is transforming and expanding financial services products such as intermediated and non-intermediated financing services, shifting the focus from financial development to financial inclusion, and increasing alternative financing schemes.

FinTech is applied in three major areas of financial services (see Table 1): (i) payments clearing and settlement services; (ii) credit, deposits and capital raising services; and (iii) investment management services. Different drivers determine the proliferation and adoption of FinTech.The rise of FinTech in developing countries is driven by economic necessities and gaps in the provision of financial services and products (Arner et al., 2015; Frost, 2020). Da Silva (2018) opined that the factors for rapid FinTech growth in emerging markets include (i) demand for new financial services, because most financial markets in developing countries are at a nascent stage; (ii) low depth for financial inclusion, thus opportunities for FinTech entrants; and (iii) penetration of internet and mobile services, thus increasing FinTech expansion. That is why most FinTech research in developing countries is concentrated on mobile payments, peer-to-peer loans and money transfers, which are transformative to inclusive economic development (Arner et al., 2015). The most successful example is M-Pesa in East Africa, which was launched by Safaricom in 2007 in Kenya (Nyamongo & Ndirangu, 2015). In contrast, the rise of FinTech in developed countries is driven by the regulatory and compliance demands of the post-2008 global financial crisis (Arner et al., 2015; Frost, 2020). Ahn and Lee (2019) found that emotional, economic, and convenience values are the main drivers for customers' acceptance of internet-based banks such as KaKao Bank in South Korea. Other factors that drive FinTech adoption across countries include unmet demands, demographic changes, competition, cost of financing and other macroeconomic factors (Frost, 2020).

3. Methodology

Two common literature review methods are a traditional survey and a systematic review. The latter differs from the former because it is standardised, scientific, transparent, and can be replicated. A systematic literature review helps to search publications based on defined eligibility, assess the existing knowledge, and draw reliable findings and recommendations for policymakers, practitioners and academia. Different protocols used for systematic literature review include Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) (Page et al., 2021); Search, Appraisal, Synthesis, and Analysis (SALSA) (Grant & Booth, 2009); Protocol, Search, Appraisal, Synthesis, Analysis and Reporting (PSALSAR) (Mengist, Soromessa, & Legese, 2020); Cochrane, the Campbell Collaboration, the Collaboration for Environmental Evidence (CEE) (Gusenbauer & Haddaway, 2020); Quality of Reporting of Meta-analysis (QUOROM) (Petticrew & Roberts, 2006); and other systematic review guides provided by different authors (Tranfield, Denyer, & Smart, 2003; Y. Xiao & Watson, 2019).

Like previous studies in environmental science, social science and economics, this paper uses PSALSAR and PRISMA (Ismail, Ramly, & Hamid, 2021; Mengist et al., 2020; Siksnelyte-Butkiene, 2021). PSALSAR is an extension of the SALSA framework used to evaluate the existing literature, gaps and trends. PRISMA was developed to facilitate systematic reviews of studies examining the effects of health interventions. However, this scientific standard has been used for systematic reviews of business, economics and finance studies. The standard was recently updated (in 2020) as PRISMA 2020 and has a checklist as a supplement (Page et al., 2021). The checklist offers further guidance on using PRISMA 2020, including describing the rationale for the review, the databases to be searched, the inclusion and exclusion criteria, and the selection and analysis process.

Table 2
PSALSAR Framework.

Steps	Outcomes	Methods	
Protocol	Scope of the study	Scope	Review studies about the use of FinTech on SME financing for the period 2008–2022
Search	Search strategy	Search databases	Scopus and World of Science
		Search strings	
		Key Words	*Related Words*
		FinTech	"Financial Technology" *OR* "Blockchain" *OR* "Mobile" *OR* "Digital" *OR* "Crowdfunding" *OR* "Crowd-lending" *OR* "Crowd-investing" *OR* "Marketplace Lending" *OR* "Peer-to-Peer lending" *OR* "P2P" *OR* "Alternative Financing"
		AND	
		SME	"SMEs" *OR* "SME" *OR* "Small Businesses" *OR* "Small Firms" *OR* "Small and Medium Enterprises"
		AND	
		Financing	"Lending" *OR* "Borrowing" *OR* "Finance" *OR* "Credit" *OR* "Loan" *OR* "Trade Credit" *OR* "Bank Lending" *OR* "Bank Financing" *OR* "Bank Loan" *OR* "Bank Credit" *OR* "Capital" *OR* "Venture Capital" *OR* "Debt" *OR* "Equity" *OR* "Debt Financing" *OR* "Equity Financing" *OR* "Overdraft Facility"
Appraisal	Selection of publication	Methodology	- PRISMA flow chart and checklist - Snowballing method
		Eligibility	*Inclusion criteria:*
			- *Language*: English - *Year*: 2008 to 2022 - *Subject Area*: Economics, social science, management, business, banking and finance, computer science and development studies - *Document Type*: Peer-reviewed articles
			Exclusion criteria:
			- Any content not related to FinTech and SME financing. - Proceedings, papers, early access, book chapters, editorial material and review articles
Synthesis	Data extraction and categorisation	- Data extraction template is based on the PRISMA checklist - Excel, Mendeley and Bibliometrix R software are employed to categorise data for further analysis	
Analysis	Data analysis	- Descriptive analysis, content analysis and literature classification	
	Results and discussion	- Combining the findings and drawing conclusions and recommendations	
Report	Article writing	- Presenting the findings and recommendations in journal article format	

This study uses two search databases, Scopus and Web of Science (WOS), two world-leading and competing citation databases widely used in systematic literature reviews (Singh, Singh, Karmakar, Leta, & Mayr, 2021; Zhu & Liu, 2020). The search strategy and selection of

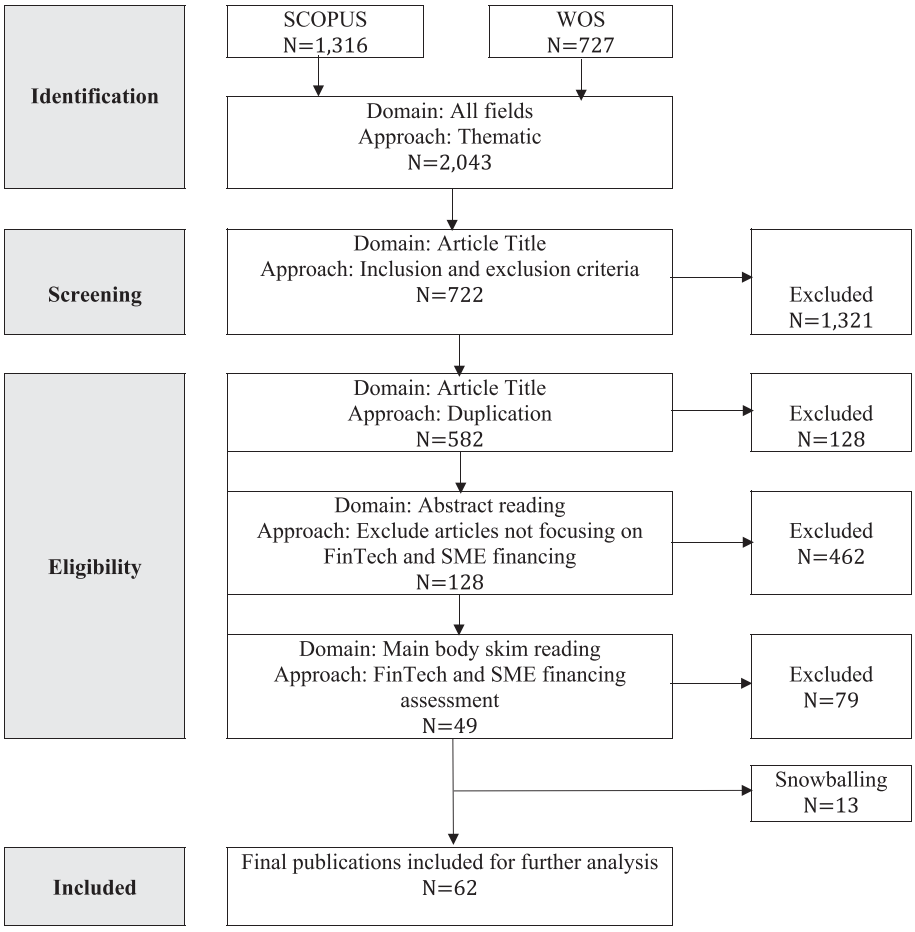

Fig. 1. PRISMA Flowchart for Screening Process on Systematic Literature Review.

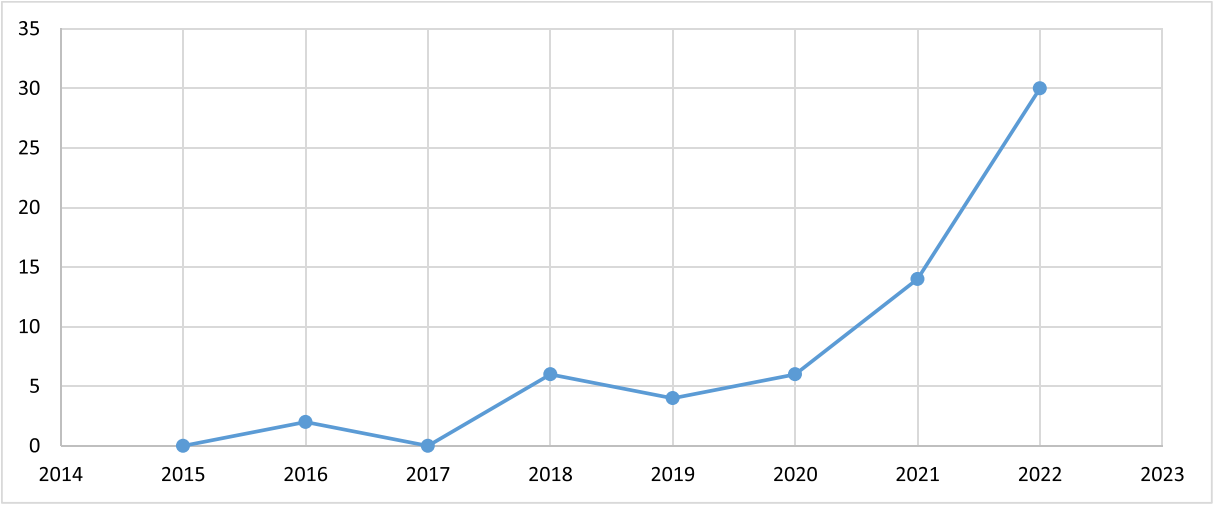

Fig. 2. Empirical studies on FinTech-enabled financing schemes to SMEs.

articles followed PSALSAR and PRISMA structured processes defined in Table 2 and Fig. 1, respectively, from 2008 when FinTech 3.0 started, to 2022. The snowball method (Babbie, 2016, p. 188) was used to find missing studies by looking at citations from the relevant sample and obtaining the final publications for analysis. The publications were analysed based on similarities and clustered in different FinTech schemes. Software packages available for bibliometric analysis include Vosviewer, Histcite, Pajek, Gephi, CiteSpace and Bibliometrix R (Barroso & Laborda, 2022; Kaur, Singh, & Singh, 2021). This study employed Mendeley, Bibliometrix R and Excel to categorise and analyse the data for ease of use.

4. Results from bibliometric analysis

The following subsection answers the research question *RQ1* about the trend of empirical publications on FinTech and SME financing by

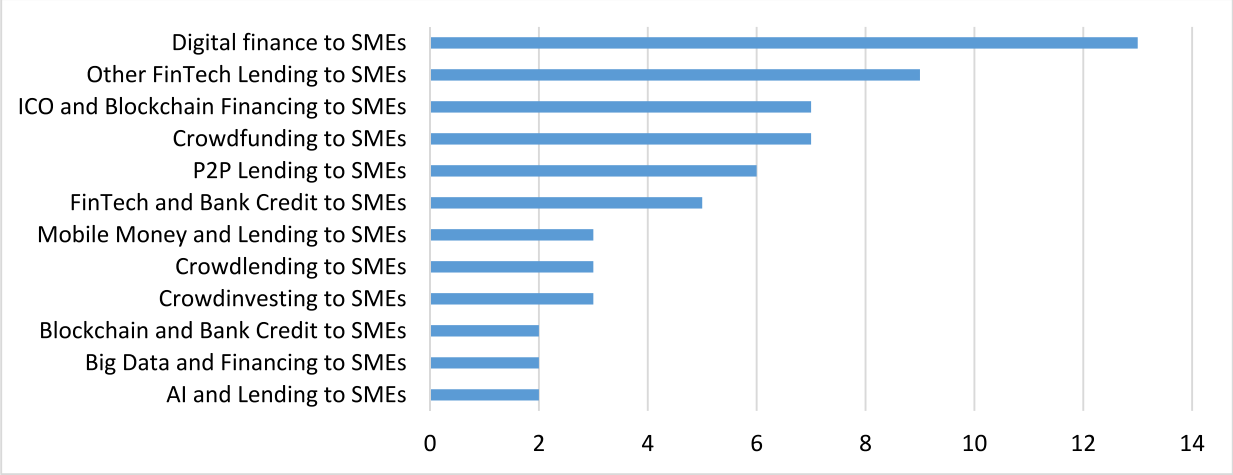

Fig. 3. Number of publications by FinTech-enabled financing schemes to SMEs.

Table 3
Countries with at least two publications in the dataset.

Rank	Country	Publications	Rank	Country	Publications
1	China	22	5	Germany	4
2	USA	9	6	Italy	3
3	UK	5	7	Malaysia	3
4	Indonesia	5			

presenting a bibliometric analysis based on the 62 reviewed empirical papers.

4.1. Publication trends over time

FinTech 3.0 started in 2008, but empirical studies exploring FinTech and SME financing began in 2016 and surged almost a decade later, with the highest number of articles published in 2022 (30). This could be because of the greater availability of data. As Fig. 2 indicates, 71% of the papers analysed in this study were published in 2021 and 2022. This demonstrates a considerable interest of scholars in conducting empirical studies on this novel subject of FinTech and SME financing.

4.2. Publications based on FinTech-enabled financing schemes to SMEs

As Fig. 3 shows, most empirical studies exploring FinTech and SME financing focus on digital finance to SMEs (13 articles), other FinTech lending to SMEs (9 articles), crowd-funding to SMEs (7 papers) and ICO and blockchain financing (7 papers). The leading digital finance research includes all online capital-raising activities outside traditional banking and capital markets. There are few empirical studies on blockchain and bank credit to SMEs (2 articles), AI and financing to SMEs (2 papers) and Big data and financing to SMEs (2 papers). These statistics show that the emergence of alternative financing, such as crowd-funding, marketplace lending and other FinTech lending to SMEs, has attracted more empirical studies (55 articles) than FinTech's use on bank lending to SMEs (7 papers).

4.3. Publication trends based on location

Based on the country of the corresponding author, Table 3 shows the countries with at least two publications in the dataset. As expected, China dominates (with 22 articles), followed by the United States (with 9 articles). Based on the dataset analysed in this paper, only China has developed an index to measure FinTech or digital finance. 13 out of 22 empirical studies in China used the digital inclusive financial index developed by the Digital Finance Research Center at Peking University as the measure for FinTech development or digital finance. The index uses versatile data of digital inclusive finance from Alipay, WeChat and other services from Ant Financial Services Group. This could be why China has more empirical studies than other countries. Other studies use the number of FinTech companies (Huang, 2022), mobile phone penetration and fixed broadband penetration (Hodula, 2022), online and mobile internet banking services (Fasano & Cappa, 2022) and internet penetration (Sheng, 2021) as the proxy for FinTech. It is, however, surprising to see only three countries in Africa featured on our dataset with one publication each: South Africa (about mobile money and lending to SMEs), Kenya (about mobile money and lending to SMEs) and Nigeria (about crowd-funding to SMEs).

4.4. Publications based on the methodology used

Looking at the data used in publications under review, 45 articles employed secondary data, while 17 used primary data. 50 articles employed quantitative empirical approaches, 11 used qualitative methods, and the remaining used mixed methods. As indicated in Fig. 4, the publications used different data sources with individual and institution surveys (15 articles), various FinTech platforms' data (11 articles), Peking University in conjunction with other databases (13 articles) and interviews (5 papers). Based on data sources, it is evident that most of the analysed empirical studies examined firm-level and provincial-level data. Only 5 out of 62 articles analysed country-level data for: OECD countries (used CrunchBase database), 5 Asian countries (used FinTech platform data, Kickstarter), 3 East African countries (employed the World Bank Enterprise Surveys), and three countries combined (UK, USA and Canada).

4.5. Top 10 publications based on citation and journal that published at least two articles

Citation analysis is a common method of measuring the article's significance based on citation frequency. Table 4 shows the most influential articles in FinTech and SME financing based on citations. These papers were published between 2016 and 2022. As for journals, *Small Business Economics* is leading with 4 articles, followed by the *Journal of Economics and Business* and *Emerging Markets Finance and Trade,* which published 3 papers each. The second cluster of journals published 2 articles each (*Finance Research Letters*, *Journal of Asian Finance Economics and Business*, *Pacific-Basin Finance Journal* and *The Review of Financial Studies*). The remaining 44 articles were published in 44 different journals.

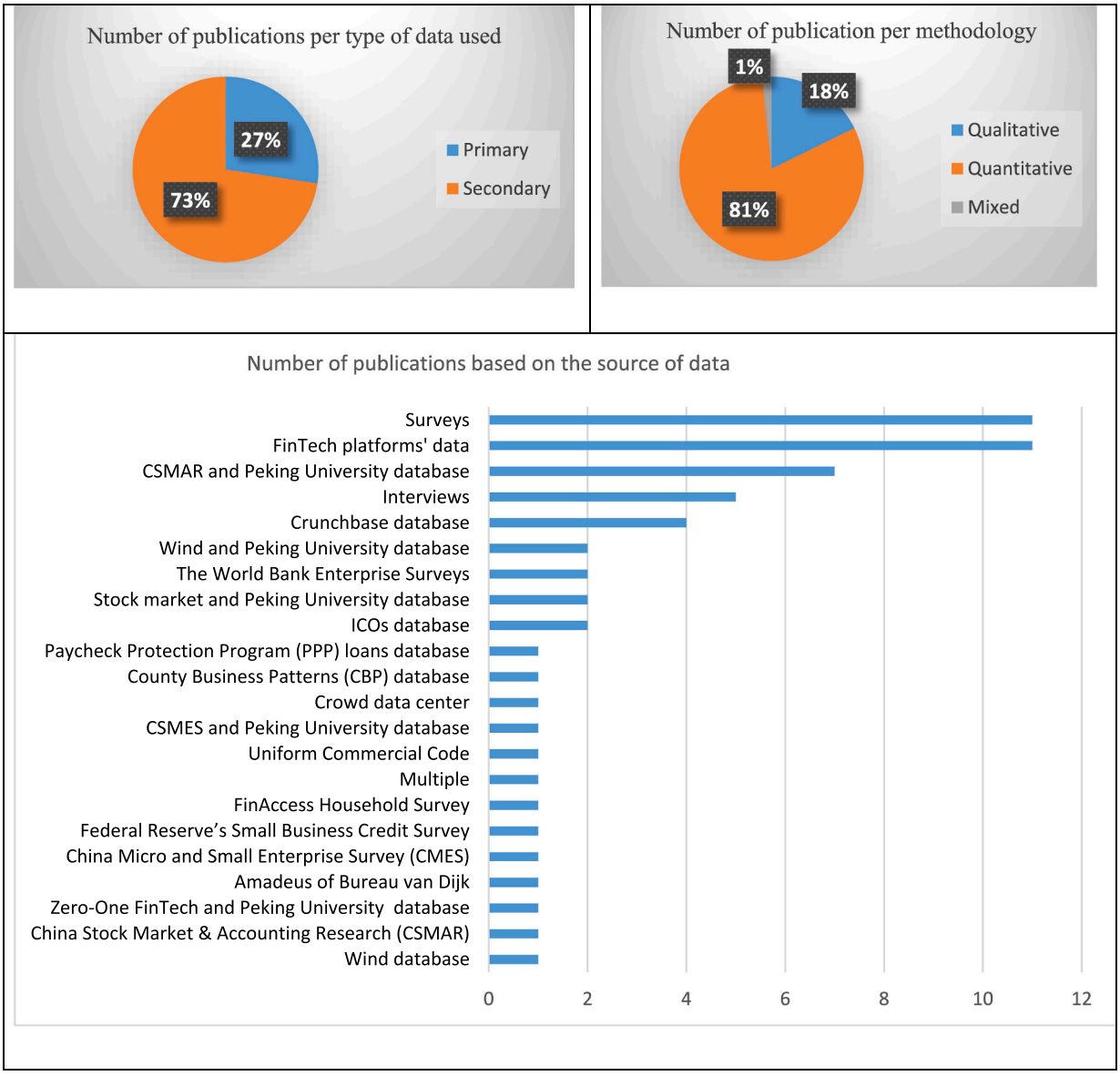

Fig. 4. Publications based on employed methodology.
Source: Authors based on Bibliometric analysis

5. Findings from content analysis

This section responds to the research question *RQ2* about the findings from the empirical literature on FinTech and SME financing under the study period. Financial and non-financial institutions use FinTech actively. Financial institutions use FinTech for intermediated financial services or indirect financing, while non-financial institutions use FinTech for disintermediated financial services or direct financing. SMEs seek financing from both financial and non-financial institutions. Thus, the results for our content analysis are clustered into two groups: "FinTech and bank credit to SMEs" and "FinTech and non-bank financing to SMEs".

5.1. FinTech and bank credit to SMEs

Traditional banks are leveraging the advancement of FinTech to increase their lending portfolio by reducing information asymmetry and transaction costs. FinTech is improving banks' efficiency in terms of profitability, innovations, risk control, business models, operating costs, service delivery, competitiveness, financial intermediation and overall financial sector development (Navaretti et al., 2018; Okoli & Tewari, 2020; Wang, Xiuping, & Zhang, 2021). Banks are collaborating with FinTech companies to improve the supply of credit and delivery of financial services. FinTech companies are also partnering with banks to penetrate the market and increase the proliferation of new products (Bömer & Maxin, 2018). The complementarity between banks and FinTech companies is becoming essential because FinTech offers unbundled services, and their business models converge with banks. In contrast, banks offer bundled services with significant economies of scale (Navaretti et al., 2018). Collaboration between FinTech and banks is also compelled by digital strategy through outsourcing, incubation and acquisition models (Fermay, Kertopati, Santosa, & Eprianto, 2018; Hornuf, Klus, Lohwasser, & Schwienbacher, 2020). For example, in China, it has been established that SMEs' access to financing and banks' operational efficiency has increased since 2015 due to emerging FinTech and Internet-only banks such as WeBank and MyBank (Chen, 2020). Nevertheless, few studies on FinTech and bank lending to SMEs are empirical, and their findings are summarised in Table 5.

Table 4
Articles with the most citations.

No	Author	Theme	Citations
1	Haddad and Hornuf (2019)	Other FinTech lending to SMEs	626
2	Adhami et al. (2018)	ICOs and blockchain financing to SMEs	625
3	Howell and Niessner (2020)	ICOs and blockchain financing to SMEs	567
4	Jagtiani and Lemieux (2018)	Other FinTech lending to SMEs	341
5	Maier (2016)	Crowdlending to SMEs	154
6	Rosavina, Rahadi, Kitri, Nuraeni, and Mayangsari (2019)	P2P lending to SMEs	108
7	Wang et al. (2019)	Blockchain and bank credit to SMEs	104
8	Sheng (2021)	FinTech and bank credit to SMEs	103
9	Gopal and Schnabl (2022)	Other FinTech lending	102
10	Islam, Muzi, and Meza (2018)	Mobile money and lending to SMEs	89

5.2. FinTech and non-bank credit to SMEs

SMEs that are financially constrained, innovative, or with long banking relationships are more likely to seek alternative financing schemes (Xiang et al., 2021). These alternative financing schemes overcome information asymmetry through credible online verification of information, social networks and big data. The factors that lead SMEs to seek alternative financing schemes include easier access and flexible loan amounts, simple and rapid lending processes, lower transactional costs and lending rates compared to traditional banks (Farag & Johan, 2021; Rosavina et al., 2019; Temelkov & Samonikov, 2018; Xiang et al., 2021).

Marketplace lending or peer-to-peer (P2P) lending offers opportunities for SMEs to access financing because it is easy and faster, with low interest rates and reduced operating costs (Abbasi, Alam, Brohi, Brohi, & Nasim, 2021). Furthermore, P2P lending proliferates because of SMEs and consumers' financial constraints (Hsu, Li, & Bao, 2021). However, most empirical studies focus on P2P lending to individuals, and there are limited studies on P2P lending to SMEs. Crowd-funding is another alternative financing scheme which has three categories: fundraising based on rewards and donations (mostly called crowd-funding), lending-based (also called crowd-lending), and equity-based (crowd-investing or investment-based crowd-funding). ICOs are proliferating as alternative financing for small and start-up enterprises because ICOs have almost no intermediation costs and overcome information asymmetry (Adhami et al., 2018; Howell & Niessner, 2020). Big data is described as information assets with five "V" dimensions: Volume (high volume of data sets), Velocity (speed of collecting and processing data), Variety (variety of data sets), Veracity (quality of data) and Value (data usefulness) (Onay & Öztürk, 2018). FinTech lenders also leverage big data and artificial intelligence (AI), such as machine learning and deep learning, to assess SMEs' creditworthiness. Some studies (see Table 6) analyse the determinants or the impact of FinTech lending to SMEs without explicitly mentioning the type of FinTech. There are few empirical studies on alternative financing schemes for SMEs, as summarised in Table 6.

6. Research gaps and areas of future research on FinTech and SME financing

This section answers the research question *RQ3* about the research gaps and future research trends on FinTech and SME financing. The reviewed literature shows that FinTech is fundamentally changing financial intermediation to disintermediation through alternative financing schemes (Drummer et al., 2017; Farag & Johan, 2021).

Table 5
Findings from the empirical literature on FinTech and bank credit to SMEs.

FinTech Business Model	Findings	Authors
Internet-based financial services and bank credit to SMEs	Use of FinTech on bank lending: - Complements relationship banking for SMEs. SMEs' access to finance will diminish if FinTech substitutes relationship banking, which enable banks to collect soft information. - Improves the bank's operational efficiency, loan screening, monitoring and lending decisions. - Promotes supply of credit to SMEs by large banks. - Reduces bank's operational costs and lending interest rates to SMEs. Furthermore, Internet-only banks are not restricted by geographical boundaries but pay high interest rates and charge low lending rates. - Helps to reduce information asymmetry between banks and SMEs by gaining access to more information and turning soft information into hard information. - Alleviates financing constraints on SMEs and promotes SMEs' investment efficiency. Other empirical findings on FinTech and bank credit to SMEs include: - FinTech lending and bank loans have complementary and substituting effects on loans extended to SMEs. FinTech has a complementary impact through promoting bank credit to SMEs. However, FinTech has a substituting effect on markets with high bank concentration, margins, and lending rates. - Internet banking reduces credit to SMEs in Italy. Although Internet banking allows banking operations to be carried out at a distance and will enable banks to collect standardised hard information, it hampers banks in collecting soft information from SMEs. Thus, soft and hard information is vital for banks to make credit decisions. - Local banks and digital financial inclusion can reduce SMEs' financing constraints. However, the interaction of these two variables (digital financial inclusion and number of local banks) has substitution	Flögel and Beckamp (2020), Jakšič and Marinč (2019), Ahn and Lee (2019), Chen (2020), Sheng (2021), Huang, Tao, Luo, Ye, and Lei (2022) Hodula (2022), Fasano and Cappa (2022) and Lu, Wu, Li, and Nguyen (2022).

(*continued on next page*)

Table 5 (*continued*)

FinTech Business Model	Findings	Authors
	effects on alleviating SMEs' financing constraints.	
Blockchain and bank credit to SMEs	Blockchain-embedded bank lending model: - Address SMEs' problem of information asymmetry and credit rationing. Blockchain's decentralisation and consensus mechanism help to keep records of SMEs' loan repayments and defaults on a distributed ledger. Thus, banks can lend to SMEs based on their transparent track records and credibility stored on blockchain. - Drives SMEs' intentions to borrow based on perceived risk, fairness and rewards. The reviewed papers propose a blockchain-based lending system that involves three leading players: government, financial institutions and SMEs.	Wang et al. (2019) and Sun, Dedahanov, Shin, and Li (2021)

Furthermore, disintermediation has improved the efficient allocation of resources, enabling SMEs, the engines of growth in most countries, to have access to capital. Alternative financing schemes have also helped better understand enterprises' financing gaps (Farag & Johan, 2021; Xiang et al., 2021). However, our review found some research gaps in themes, geographical coverage, and emerging technologies. Table 7 presents the research gaps and recommended future studies.

7. Challenges and policy recommendations to promote FinTech and SME financing

The reviewed empirical studies provide several challenges and policy recommendations for promoting FinTech and SME financing in developing and emerging countries. We summarise those challenges and policy recommendations in Table 8 as a response to research question *RQ4*.

8. Conclusion

This paper systematically reviewed the empirical studies investigating FinTech and SME financing from 2008 to 2022 using PSALSAR and PRISMA protocols. 2043 publications were searched from Scopus and Web of Science (WOS) databases, and only 62 met the selection criteria for this review. The results show that there are few studies on FinTech and SME financing which are empirical in nature. FinTech services and emerging technologies such as internet-based financial services, blockchain, alternative lending (crowd-lending and marketplace (P2P) lending), alternative financing (crowd-investing and crowdfunding), artificial intelligence, big data and analytics have increased the ability for banking and non-banking institutions to collect accurate information about SMEs, and therefore contribute to reducing the information asymmetry. FinTech services and emerging technologies have also increased information sharing among lenders and have expanded lending channels and institutions. Most importantly, FinTech has reduced the cost and increased the speed and quality of the lending cycle from processing information, establishing customer pipelines, screening, appraising, and monitoring to loan repayment.

The bibliometric analysis shows the following insights. First,

Table 6
FinTech and non-bank credit to SMEs.

FinTech Business Model	Findings	Authors
Marketplace lending (P2P) to SMEs	- Loan flexibility and processing, loan amounts and costs, and interest rates are critical compelling factors for SMEs' adoption of P2P lending in Indonesia. - SME borrowers using P2P lending have more debt and higher returns than a broad sample of SMEs not using P2P lending in the UK. - SMEs with low leverage ratio, low risk, low levels of prior capital expenditures and small assets are likely to seek financing from P2P platforms rather than banks. - P2P lending increases access to finance for SMEs and entrepreneurship. - Strong institutional qualities positively influence P2P and SME finance. - Detailed financial information does not influence investors, but higher interest rates are profitable to investors and do not affect SMEs' loan repayments in the largest P2P platform in Germany.	Rosavina et al. (2019), Sabato, Altman, and Andreeva (2019), Coakley and Huang (2020), Abbasi et al. (2021), Cumming and Hornuf (2022), and Cumming, Farag, Johan, and McGowan (2022).
Crowd-funding (reward-based) to SMEs	- Crowd-funding is suitable for new and small business ventures but is not a very popular financing model in developing countries - Small businesses are more likely to attract crowd-funding from potential funders with extrinsic motivations as a reward. - Crowd-funding platforms are effective for financing entrepreneurs in the Middle East. - Use of social media and crowd-funding information significantly influences SMEs' adoption of Islamic crowd-funding. - SMEs in creative industries were found to have reached 44% success rate on crowd-funding in 7 countries in South East Asia, but the success rate in the USA, UK and Canada was found to be 23%.	Rupeika-Apoga and Saksonova (2018), Cox and Nguyen (2018), Dikaputra, Sulung, and Kot (2019), Ochinanwata, Ezepue, Nwankwo, Ochinanwata, and Igwe (2021), Abdeldayem and Aldulaimi (2021), Kazaure, Abdullah, Zawawi, and Hamzah (2021), and Rijanto (2022).
Crowd-lending	- Crowd-lending investors require less business information, which is advantageous for SMEs' access to finance in Italy. - SMEs are driven to crowd-lending because of low financial costs, the speed of access to credit, flexibility, simplicity of credit conditions and process transparency in Europe and Peru. - SMEs with high revenue growth and well-developed business operations prefer crowd-lending as they seek	Maier (2016), Gómez, Navarro-Barranzuela, and Marchena-Ojeda (2022), Kukk (2022) and Stefanelli, Ferilli, and Boscia (2022).

(*continued on next page*)

Table 6 (*continued*)

FinTech Business Model	Findings	Authors
	to raise a high amount of funds.	
Crowd-investing	- Crowd-investing is suitable for start-up enterprises in Germany. - Crowd-investing significantly impacts SMEs' financing, performance and growth in the UK. - SMEs with low revenue and at a developing stage prefer crowd-investing.	Grundy and Ohmer (2016), Eldridge, Nisar, and Torchia (2021) and Kukk (2022).
Blockchain and non-bank financing to SMEs	- Entrepreneurs and start-ups leverage ICOs, blockchain-based securities and lending systems because of usability, connectivity, customisation, and no intermediation cost and information asymmetry. - Blockchain pass-through model based on blockchain's decentralised and tamper-evident characteristics improves supply chain financing to SMEs by reducing information asymmetry and mistrust.	Adhami et al. (2018), Howell and Niessner (2020), Kwon, You, and Lee (2020), Schückes and Gutmann (2021), Ma, Liu, and Deng (2022), Xiao, Salleh, and Cheng (2022) and Jiang et al. (2022).
Artificial intelligence (AI) and financing to SMEs	- AI finance alleviates financing constraints for small, non-state-owned firms in China. - AI-based trade credit system increases financial gains and sustainability of SMEs in Pakistan.	Shao et al. (2022) and Shah et al. (2022).
Big data analytics and financing to SMEs	- Digital platforms using big data analytics help SMEs obtain supply chain finance. - Big data help banks increase credit to SMEs through improved credit risk assessments for online supply chain financing.	Wang, Ding, Yu, and Zhao (2020) and Song et al. (2021).
Mobile money and credit to SMEs	- The use of mobile money by small businesses in East Africa reduced credit constraints and positively increased creditworthiness and liquidity. - Use of mobile money and mobile banking increases SMEs' probability of accessing informal and formal credit.	Islam et al. (2018), Mdoe and Kinyanjui (2018), and Lorenz and Pommet (2021).
Digital finance to SMEs	Digital finance: - Promotes direct financing to SMEs and increases financial disintermediation. - Alleviates financing constraints and stimulates SMEs' innovations and financial performance. - Increases SMEs' sustainability. SMEs are less likely to go bankrupt or face financing and sales volatility. - Increases efficiency of allocation of financial resources and promotes development of SMEs. - Improves SMEs' information transparency and financial leverage.	Zhang, Zhao, Wang, and Dong (2022) Yao and Yang (2022), Chen, Huang, Lin, and Sheng (2022), Xie and Liu (2022), Lin, Peng, and Wu (2022), Ji, Shi, and Zhang (2022), Xia, Qiao, and Xie (2022), Li, Wei, and Guo (2022), Huang et al. (2022), Chen and Yoon (2022), Wu and Huang (2022), Ye, Yuan, and Guan (2022) and Zhang, Xing, and Guo (2023)
	- Reduces two-way information asymmetry between lenders and borrowers, alleviating financing constraints. - Promotes the investment behaviour of micro and small enterprises. - Increases SMEs' access to debt financing, reduces financing costs and constraints, and reduces SMEs' resilience to other shocks such as COVID-19.	
Other FinTech lending to SMEs	- FinTech lending penetrates underserved areas by traditional banks, where SMEs have more difficulty accessing loans. - SMEs that borrowed from FinTech lenders have better growth expectations than those from traditional banks. - Social networks (soft information), economic attributes (borrowing history, loan utilisation and payment records) and risk perception (credit documentation) have a significant influence on SMEs' access to FinTech lending. - Education, size, and business age affect the promotion of FinTech lending and payments to MSMEs in Indonesia. - FinTech lenders and other finance companies were the main suppliers of loans to SMEs in the USA. - The ease of use had a positive effect on SMEs' adoption of online credit platforms subsidised by the government in Indonesia.	Jagtiani and Lemieux (2018), Haddad and Hornuf (2019), Purnamasari, Pramono, Haryatiningsih, Ismail, and Shafie (2020), Spatia et al. (2021), Rokhim, Mayasari, and Wulandari (2021), Barkley and Schweitzer (2021), Gopal and Schnabl (2022), and Erel and Liebersohn (2022).

although FinTech 3.0 started in 2008, the empirical studies aiming at FinTech and SME financing surged a decade later. 71% of the analysed studies were published in 2021 and 2022. This demonstrates scholars' considerable interest in conducting empirical studies on this novel subject as data continue to be available. Second, the review shows that the empirical studies on emerging alternative financing, such as crowdfunding and marketplace lending to SMEs (89%), are more than those on FinTech and bank lending to SMEs (11%). Third, publication trends based on location show that China dominates (36%), followed by the United States (15%). On the African continent, only 3 out of 54 countries featured on our dataset with one publication each: South Africa, Kenya and Nigeria. Fourth, most empirical studies are based on surveys and FinTech platform data, with 27% of the publications using primary data and 73% employing secondary data. 81% of empirical studies are quantitative, 18% qualitative and 1% employ mixed methods. Lastly, the *Small Business Economics* journal published more articles on different FinTech initiatives on SMEs' financing than any other journal.

The content analysis illustrates the following findings: First, the use of FinTech and emerging technologies by banks has improved their operational efficiency and lending processes, reduced information asymmetry and credit rationing, reduced transaction costs, and alleviated financing constraints for SMEs. However, FinTech impedes the ability of banks to collect SMEs' soft information through relationship

Table 7
Research gaps and future research suggestions on FinTech and SME financing.

Research Gaps	Future Research Suggestions
There is a shortage of research on FinTech and bank lending to SMEs globally; only 7 out of 62 studies examined how FinTech and emerging technologies can help banks extend more financing to SMEs.	- Future studies on FinTech and SME financing can focus on how banks can leverage FinTech and emerging technologies to scale up credit to SMEs, particularly in developing countries, where banks still dominate financial markets.
Out of the 62 empirical studies reviewed, only 5 used country-level data. The reviewed studies are limited to a region, case study, platform or specific locality. Therefore, it is difficult to generalise their results or apply their recommendations in a different context.	- Future empirical studies on the impact of FinTech on SME financing should have broader geographical coverage as country-level data becomes available. Cross-country empirical studies will provide insights into the relationship between FinTech and SME financing.
The literature does not tell much about the collaboration between FinTech companies and financial institutions and whether it will affect SME financing. The literature talks more about complementarity and substitution between FinTech and bank lending.	- Future empirical studies should examine whether collaboration and interactions between FinTech companies and banking institutions will help to alleviate the moral hazards and adverse selection on credit markets. This will provide more understanding of how to serve better SMEs in raising capital.
81% of the empirical studies are quantitative, 18% are qualitative, and 1% are mixed methods. Moreover, these studies are missing a longitudinal perspective.	- Future studies should use experimental methods and longitudinal research to examine how FinTech increases SMEs' access to finance over time and how SMEs are changing based on access to finance. - Experimental methods using innovation hubs, incubators, and accelerators, and how entrepreneurs and startups access finance using FinTech should be examined.
There are only 3 empirical studies which investigate the impact of big data analytics and artificial intelligence	- More research should explore how big data analytics, artificial intelligence and blockchain.

Table 8
Challenges and policy recommendations on FinTech and SME financing.

Challenges	Policy recommendations
There are very few studies on FinTech and SME financing in developing countries because of the unavailability of data.	Central banks in developing countries can mandate all banks to separately report their loans extended to SMEs on their credit portfolio.
There is no appropriate measure for FinTech development in Africa. China is the leading country in publishing empirical papers on this subject because there is an index measuring digital finance managed by the Digital Finance Research Center at Peking University.	There is a need to establish a FinTech index in Africa, similar to the Africa ICT infrastructure development index managed by the African Development Bank since 2008.
Relationship banking is mainly used to collect soft information from SMEs. FinTech allows financial and non-financial institutions to offer services from a distance, which hampers the collection of soft information. Soft and hard information is required to make credit decisions, especially for banks.	Financial and non-financial institutions can: - Explore how to use emerging technologies to collect soft information. - Investigate how to change the credit scoring criteria, especially for banks, to accommodate information collected through FinTech. - Build models to assess credit risk properly and to predict defaults for online credit markets.
Several risks are associated with alternative financing schemes, such as default, fraud, illiquidity, cyberattacks and lack of transparency. At low-volume transactions, disintermediation and alternative financing schemes may not pose a systemic risk to financial markets. Still, a high volume of transactions may result in financial risks and social chaos.	Governments can put in place real-time regulations and supervision capabilities as well as the use of regulatory technologies (RegTech) that will help to: - Increase transparency and reduce operational, market and credit risks for online credit markets. - Accelerate growth and sustainability of alternative financing schemes for SMEs. - Cope with the speed and breadth of the proliferation of FinTech-based alternative financing schemes.
- Despite the advantages of alternative financing schemes for SMEs, developing economies are still lagging. - There are no cross-jurisdiction regulations for alternative financing schemes. In some countries, alternative financing schemes are either unregulated, casually regulated, fully regulated, or prohibited. Thus, the growth of alternative schemes is different in various jurisdictions.	Developing and emerging countries can put in place policies and regulations that: - Allow cross-border activities for alternative financing schemes. This will help them tap into well-developed off-shore alternative financing schemes. - Support financial innovation and encourage research and development on inclusive digital finance. For example, using regulatory sandboxes as an experimentation space in some jurisdictions has helped balance stability and innovation and the expansion of alternative financing schemes. - Help build a versatile innovation ecosystem by increasing subsidies and tax returns and allocating resources to use emerging technologies to promote FinTech and SME financing. - Strengthen institutional qualities and incentives that attract more institutional investors to digital lending and financing where traditional banks underserve SMEs. The success of affordable schemes such as M-PESA is evidence of good returns on investment in FinTech services in developing countries. - Increase SMEs' participation in digital finance markets such as crowd-funding and P2P lending through

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banking due to online transactions carried out at a distance. Second, marketplace lending has increased access to finance for SMEs because of flexible loan processing and low interest rates. Third, crowd-funding was suitable for new and small business ventures, while crowd-investing is preferred by start-ups and SMEs whose revenue is small and at the developing stages. SMEs with high revenue growth and well-developed business operations favour crowd-lending because of the possibility of raising sizeable loan amounts. Third, blockchain, artificial intelligence and big data analytics have improved supply chain finance and trade credits to SMEs. Blockchain-based lending and ICOs have low intermediation costs and reduce information asymmetry. Fourth, using mobile money by small businesses has reduced SMEs' credit constraints and increased SMEs' liquidity, especially in East Africa. Fifth, digital finance and other FinTech lending have increased financial disintermediation, efficiency of allocation of financial resources and direct lending to SMEs. Lastly, access to digital finance has improved SMEs' innovation, efficiency, competitiveness, productivity, growth and resilience against bankruptcy and sales volatility shocks.

The paper identified existing research gaps and proposed areas for future research studies on FinTech and SME financing, especially empirical studies with a longitudinal perspective and broader geographical coverage. Lastly, the paper discussed the challenges of FinTech and SME financing. It made policy recommendations, especially for developing economies lagging in alternative financing schemes for SMEs and where traditional banks underserve SMEs.

Declaration of Competing Interest

The authors declare that they have no known competing financial

Table 8 (*continued*)

Challenges	Policy recommendations
	campaigns and positive media coverage.
Although bank lending is predominant in developing countries, SMEs still struggle to access credit.	Developing countries, through central banks, should: - Encourage banks to leverage and strengthen the use of FinTech to banks of all sizes to increase credit to SMEs. - Build a diversified financial market that integrates traditional and alternative financing schemes.
Many FinTech services, whether bank- or non-bank-based, run on smartphones rather than simple mobile phones, making it difficult for small businesses and entrepreneurs in developing countries to access such services.	This calls for affordable, efficient, convenient and sustainable FinTech services to SMEs in developing countries that harness financial inclusion. M-Pesa in East Africa is a classic example of an affordable and sustainable FinTech service.

interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.digbus.2023.100067.

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