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Global Patterns of Fintech Activity and Enabling Factors

Fintech and the Future of Finance Flagship Technical Note

WORLD BANK GROUP

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Acronyms

ACH	Automated Clearing House
AML/ CFT	Anti-money laundering and combating the financing of terrorism
B2P	Business to person
CDD	Customer Due Diligence
DESI	Digital Economy and Society Index
DFS	Digital Financial Services
EAP	East Asia and the Pacific
ECA	Europe and Central Asia
e-KYC	electronic know-your-customer
EMDE	Emerging Market and Developing Economies
GPSS	Global Payment Systems Surveys
ICT	Information and Communication Technology
MENA	Middle East and North Africa
MSMRs	Micro, Small, and Medium Retailers
P2B	Person to business
PE	Private Equity
RPW	Remittance Prices Weekly
CPMI	Committee for Payment Market Infrastructures
SAR	South Asia Region
SSA	Sub-Saharan Africa
VC	Venture Capital
WEF	World Economic Forum

Executive Summary

The objectives of this paper are to take stock of the available fintech-related data, to document patterns of fintech activity across the world, and to help identify enabling factors. Fintech has seen remarkable growth over the past few years and will likely continue to shape the financial sector in terms of products, business models, and industrial organization. Yet, measurement of fintech activity is challenging, complicated by both the lack of a widely accepted definition, as well as important data limitations.

This paper tackles this measurement challenge by leveraging a wide range of data sources and developing a novel, country-level index of fintech activity for 125 countries, covering the period 2014-2018. The index covers three dimensions of fintech activity: fintech firm creation and growth through the availability of early-stage equity financing; usage of fintech credit and digital payments—now the most commonly used digital financial services, especially in developing countries; and the usage of mobile distribution channels for financial services.[1]

The fintech activity index is positively correlated with countries' overall level of economic development. For instance, high-income countries generally rank higher than middle- and low-income countries not only in terms of the aggregate fintech index, but also along its four constituent dimensions. However, significant variation across both regions and income groups persists, suggesting that other enabling factors matter.

This paper then uses the index to systematically analyze the association between fintech activity and a wide range of economic and technological factors in a multi-variate regression setting. Specifically, the paper explores the role of three broad set of enabling factors: basic foundations, including information and communications technology (ICT) and financial infrastructures; financial sector development, distinguishing between the development of the banking system and capital markets; and the enabling policy environment, capturing the legal and regulatory frameworks for digital financial services.

There are three key findings in this paper. First, the estimations show that fintech activity is positively associated with ICT and financial infrastructures, though the relevance of the latter varies across types of fintech services. Specifically, the evidence indicates that ICT payments infrastructure plays a more important role in the usage of digital payment services, whereas the development of credit information systems, a financial infrastructure, is more relevant for the usage of digital lending services.

Second, the analyses also show a robust negative association between fintech activity and bank development, consistent with the view that digital financial services may have more opportunities to develop in countries where the under- and un-served share of the market is relatively large. Countries with more stringent overall banking regulations exhibit subdued fintech activity, suggesting that this is linked to a less permissive environment for innovation and fintech entrants. At the same time, there is a higher prevalence of bank app downloads in countries with more stringent banking regulations, suggesting in these cases that the digital transformation is driven by incumbents. Importantly, the

1. Nascent, but rapidly evolving digital financial products and services such as central bank digital currencies, crypto-assets, stablecoins, and decentralized finance (DeFi) are beyond the scope of the current version of our index.

estimations also show that fintech activity is positively correlated with capital market development. These correlations stem from the development of digital financial services by institutions other than banks, such as fintech companies. The positive association with capital market development suggests that a supportive funding environment for fintech firms, especially start-up equity financing, can play an important role. For example, the mobile app data show that downloads of non-banking apps are significantly positively related to the development of capital markets but negatively associated with banking system development. The opposite patterns are observed for bank app downloads. The analysis thus supports the idea that the distinction between incumbent banks and fintech companies is particularly important when exploring the potential drivers of fintech activity.

Third, the empirical results are consistent with a high-quality policy environment as a necessary, but insufficient condition for fintech development. Other factors need to be in place as well for fintech activity to flourish. The degree of fintech activity is consistently on the low end of the distribution in countries scoring poorly on policy indices that capture the existence of legal and regulatory frameworks relevant for digital financial services. Whereas, it varies widely across countries scoring high on these indices. In fact, there are several countries that despite having a supportive enabling policy environment exhibit relatively low levels of fintech activity. Finally, regulation could have positive and stabilizing impact on fintech activity in the longer term. These benefits are not likely to be reflected in the analysis, given the relatively short time horizon.

Regarding the role of sector-specific legislation and regulations, our results show mixed patterns. While the existence of laws and regulations for e-money, digital IDs, and e-signatures—electronic know-your-customer (e-KYC) frameworks—tend to be positively associated with fintech activity, the coefficient on consumer protection tends to be negative. The results, however, are not as forceful as those related to the other set of enabling factors and may reflect the complexities of policy interactions, pre-conditions, and tradeoffs at different levels of fintech development as well as measurement challenges. Moreover, it is important to recognize that alternative policy combinations can promote innovation and foster fintech activity, with similar outcomes. Overall, the demands on the enabling environment will likely evolve as fintech activity develops. Finding the right balance between trade-offs at every stage of fintech development remains essential to promote activity and innovation while keeping excessive risks in check.

Finally, separate in-depth analyses documented in the appendices explore two additional topics: the impact of the pandemic on finance app downloads and the link between the digitization of remittances services and remittance costs. On the former, the paper's analysis of mobile app download trends indicates that the pandemic may have accelerated fintech adoption. Moreover, the evidence indicates that the strict social distancing practices, including government implemented containment measures such as lockdowns, quarantines, and travel restrictions required to mitigate the spread of the coronavirus, has amplified the use of digital financial services. On the latter, the results indicate that digital service providers may help lower the costs of cross-border remittances, a key financial service for households in many EMDEs. Specifically, the analysis shows that remittances costs are lower in corridors with a higher prevalence of digital service providers.

1. Introduction

Fintech has seen remarkable growth over the past few years and has transformed the provision of financial services along several dimensions (for example, IMF and World Bank 2019; Fintech Market Participants Survey[2]).[3] For users, digital technologies enabled by the near-ubiquity of cell and smart phones offer an opportunity to access faster, more affordable, more tailored, more secure, and more convenient financial services, especially for those that are under- or unserved.[4] For both incumbents and new fintech financial service providers, the costs of offering customers digital products can be considerably lower than those using physical infrastructures and relying mostly on paper- and human-based business models. Moreover, while traditional financial services are predominantly built on face-to-face interactions with financial service providers - many relying on cash transactions - digital financial services enable remote, contactless, and cashless transactions. Further, big tech companies have expanded into financial services by leveraging their large platforms and troves of alternative customer data that can be analyzed for insight through big data analytics. These developments have enabled financial services providers to serve more customers and compete with a broader set of products and at lower prices, although competitive outcomes are not predetermined (Market Structure note). Fintech thus has the potential to boost financial inclusion and enable productivity gains across countries at different stages of development, though the associated risks need to be carefully managed (Pazarbasioglu et al. 2020; IMF and World Bank 2018; Financial Stability Board 2017; McKinsey 2016).[5] Fintech adoption can also benefit governments by improving the efficiency, responsiveness, and transparency of government operations, including enabling the rapid disbursement of cash transfers, reducing leakage in public expenditure, and increasing tax revenues.

A worldwide Google Trend search of the word "fintech" showcases the growing interest on fintech, with a remarkable increase since early 2014 (figure 1). Importantly, the COVID-19 pandemic has accelerated the shift toward fintech adoption, including by traditional financial institutions. For example, we document a marked spike in worldwide financial mobile application (app) downloads during the peak months of the COVID-19 pandemic.[6]

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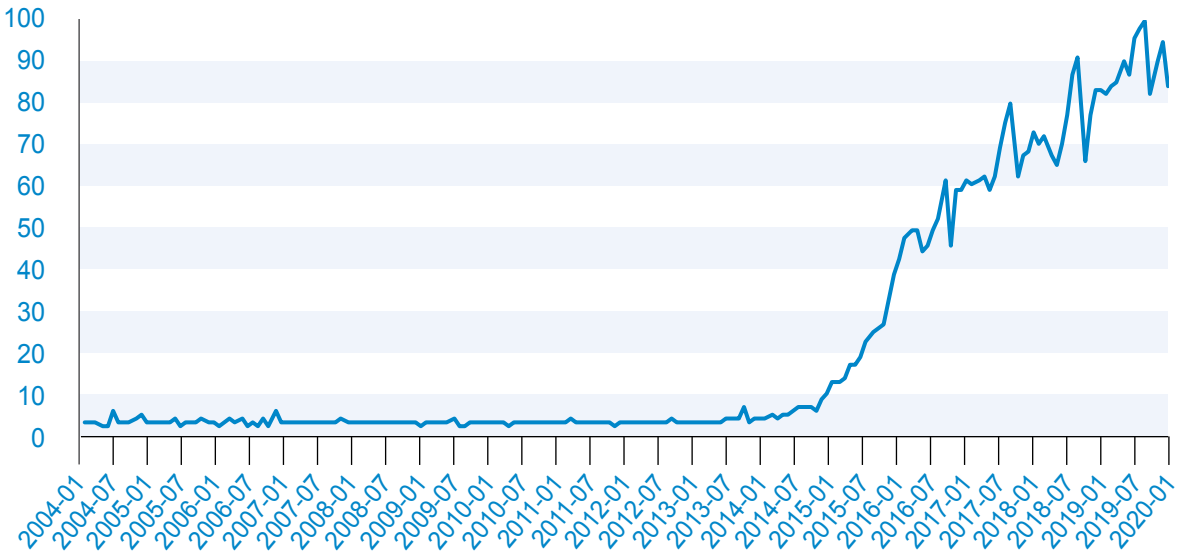
2. Global Market Survey: Digital Technology and the Future of Finance (Fintech Market Participants Survey) by Erik Feyen, Harish Natarajan, Guillermo Rabadan, Robert Paul Heffernan, Matthew Saal and Arpita Sarkar.
3. Various definitions of fintech exist. We adopt the broad definition of fintech from International Monetary Fund and World Bank Group (2018) to describe advances in technology that have the potential to transform the provision of financial services spurring the development of new business models, applications, processes, and products. Examples include e-money, peer-to-peer lending, credit scoring and decisioning, robo advisory services, and distributed ledger technology.
4. For instance, the use of e-money rather than cash saves considerable travel time and cost, reduces the risk of theft, and boosts convenience. Digital wallets can be used for a wide range of payment transactions such as receiving remittances, wages, and government subsidies, making purchases, or paying utility bills and school fees. Moreover, as individuals and businesses make digital payments, they create an electronic record of their receipts/sales and expenditures, which enables financial service providers to assess their credit risk.
5. Despite these potential benefits, the accelerating growth of digital financial services could pose various risks to the stability and integrity of the financial system if regulation and supervision do not keep pace (for example, Financial Stability Board 2017; IMF and World Bank 2018). For instance, the development of digital lending is raising concerns about predatory lending practices (for example, high late payment fees). Focusing on digital credit origination, Chava and Paradkar (2018) suggest that entry of fintech credit platforms can leave consumers more indebted, with increased default probabilities. Some other risks include cybersecurity risks, data privacy risks (for example, unauthorized disclosure, misuse of personal data), identity fraud, discrimination emerging from big data analytics (for example, imperfectly calibrated algorithms), and regulatory arbitrage, among others. Embracing the benefits while mitigating the risks of fintech calls for a proportionate, technology-neutral regulatory and supervisory response that focuses on activities and risks rather than entities, where appropriate (see Regulation and Supervision of Fintech: Considerations for EMDE Policymakers (Regulation note) by Tatiana Alonso Gispert, Pierre-Laurent Chatain, Karl Driessen, Danilo Palermo and Ariadne Plaitakis with contributions from Ana M. Carjaval and Matei Dohotaru).
6. The pandemic appears to also have changed the considerations for some central banks on central bank digital currencies (CBDCs). See for example Auer et al. (2020a) and Boar and Wehrli (2021).

Figure 1. Worldwide Google Searches for "Fintech"



Source: World Bank staff.
This figure shows an index of worldwide google searches for the word "fintech." The index takes the value 100 at its peak month over the period January 2004 to March 2020, indicating the maximum popularity of the word.

But this large global uptake in interest in fintech masks significant cross-country heterogeneity. While fintech is currently being adopted all over the world, countries are at different stages of fintech adoption. Some countries in Africa have emerged as leaders in mobile money, whereas others in Asia have expanded beyond payments services, notably China, with some fintech companies offering a wide range of financial services with a global footprint (Financial Stability Board 2020). But even within geographical regions, important differences exist. The increasing digitalization of financial services in recent years and its acceleration during the COVID-19 pandemic call for a better characterization and understanding of fintech development and its enabling factors.

The aim of this paper is two-fold: to measure fintech activity across countries and to explore the factors that potentially enable fintech development and may help explain the substantial variation across countries. To do so, we leverage a wide range of data sources. Building on existing work, the diagram below shows a framework to illustrate the guiding principles and hypotheses underlying the analysis in this paper (see CPMI and World Bank 2016 and 2020, hereafter referred to as "PAFI"; GSMA 2019a,b). Appendix 1 provides a detailed overview of the structure and indicators in our fintech activity and enablers indices and appendix 2 highlights several important data limitations.

First, we develop a comprehensive measure of fintech activity across countries, which captures three different dimensions of fintech development, comprising four pillars that reflect both supply and demand forces:[7]

7. Nascent, but rapidly evolving digital financial services which are often based on distributed ledger technology such as crypto-assets, stablecoins, central bank digital currencies, Decentralized Finance (DeFi), and tokenized assets are beyond the scope of this paper. These innovations have the potential to disintermediate or change certain roles of traditional financial institutions. They could also enhance the disruptive effects of new fintech entrants by enlarging the space to compete with intermediation activities of traditional financial institutions. For example, lower contracting and verification costs and reduced informational asymmetries could help contest incumbents.

- **Fintech firm creation and growth.** We proxy this dimension with an indicator measuring:

    1. Equity investments in fintech companies;

- **Usage of digital forms of common financial services.** In particular, we focus on:

    2. Usage of fintech credit (facilitated by electronic (online) platforms);
    3. Usage of digital payment services by households and firms;

- **Mobile distribution channels.** Given the rapid adoption of mobile devices, we analyze:

    4. Downloads of finance mobile phone applications (apps).

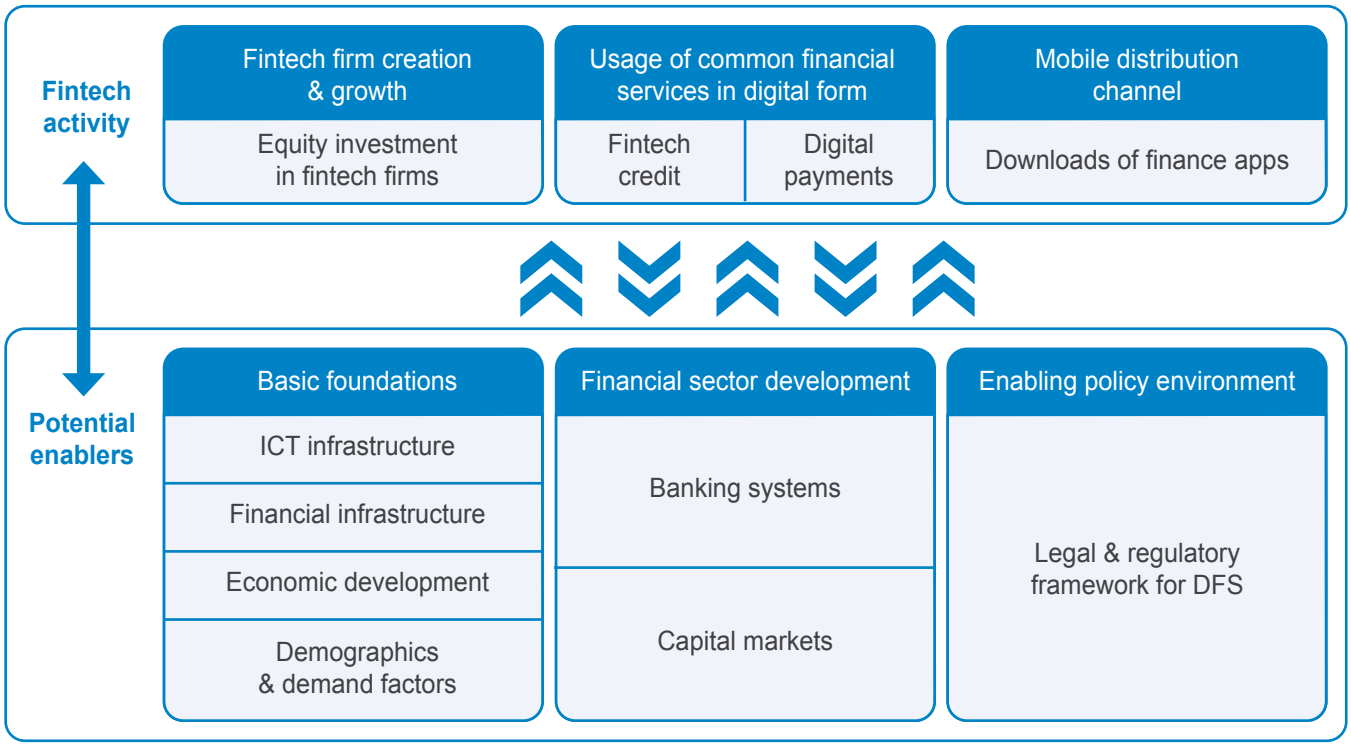
Second, we explore several enablers of fintech activity that may help explain differences across countries, grouping them into three main dimensions:

1. **Basic foundations.** This dimension encompasses both information and communications technology (ICT) infrastructure as well as financial infrastructure (for example, credit information systems). This dimension also covers the level of economic development and demographics.
2. **Financial sector development.** This dimension captures financial depth, efficiency, and inclusion and distinguishes between the banking sector and capital markets.
3. **Enabling policy environment.** This dimension covers the existence of sector-specific regulation and supervision related to digital financial services (for example, regulations related to e-money, e-KYC, and digital consumer protection).

Given the limited (or sometimes nonexistent) time series coverage for many indicators, our analysis focuses on the cross-section dimension over the 2014-2018 period.

In addition to using a systematic regression approach to evaluate the association between fintech activity and enabling factors, we also separately explore in the appendices several topics in more depth: the impact of the pandemic on finance app downloads (appendix 3), the role of more stringent banking regulation on fintech activity (appendix 4), and the link between the digitalization of remittances services and remittance costs (appendix 5).

A Guiding Framework for Fintech Activity



This paper contributes to the literature in several ways. First, whereas the literature often focuses on analyzing specific aspects of fintech activity (for example, payments or credit), we construct a comprehensive and multi-dimensional measure of fintech activity for a large sample of countries by drawing both from (confidential) survey data (for example, the Global Findex database and the World Bank's Global Payment Systems Survey) and novel data sources (for example, equity investments in fintech companies and mobile finance app downloads). Second, we systematically analyze the association between this novel, comprehensive index of fintech activity and a wider range of enabling factors than is typical in the literature, which allows us to better discern the differential roles of the enabling environment. Third, while some studies explore the role for fintech activity of countries' general regulatory and institutional environment, we focus on legal and regulatory data that pertain more specifically to digital financial services. Finally, in the appendices we also offer novel analysis regarding the impact of the pandemic on mobile finance app downloads and the association between remittances costs and the presence of digital service providers.

Our findings can be summarized as follows. Despite substantial variation in fintech activity across geographical regions and income groups, consistent patterns emerge from cross-country analyses. Our novel fintech activity index is positively associated with a country's overall degree of economic and institutional development, as proxied by GDP per capita. High-income countries generally have a higher level of fintech activity compared to middle- and low-income countries, not only in terms of the aggregate fintech index, but also along its four constituent pillars. These differences across income groups are particularly strong for equity investments in fintech companies, which are dominated by the world's leading financial centers (for example, Hong Kong SAR, China, Singapore, United Kingdom) and offshore financial centers (for example, Cayman Islands, Liechtenstein, Malta). They are less marked in fintech credit, which is characterized by a larger presence of low and middle-income countries at the top of the distribution (e.g. China, Kenya, Rwanda, Uganda). From a regional perspective, developing countries from East Asia and the Pacific (EAP), Europe and Central Asia (ECA), and Sub-Saharan Africa (SSA) generally exhibit a higher level of fintech activity compared to other developing countries, but a few individual countries in these regions (such as China and Kenya) tend to push up the regional average.

Although per capita income and geography proxy for many aspects of a country's stage of economic and institutional development, they do not explain all the cross-country variation in fintech activity observed in the data. To better understand the patterns of fintech development across countries, we conduct multi-variate regression analyses using a fractional logit model, a framework that is suitable for dependent variables that lie between 0 and 1 such as the fintech activity indices developed in this paper. We regress our novel fintech activity index and each of its four components (i.e. equity investments in fintech companies, usage of fintech credit, usage of digital payments, downloads of finance apps) against the three blocks of enabling factors (basic foundations, including infrastructure, financial development, and the enabling policy environment).

First, our estimations show that fintech activity is positively correlated with widespread access, usage, efficiency, and affordability of ICT infrastructure. We also find that fintech activity is greater in countries with a more developed financial infrastructure, though the strength of this relation depends on the type of fintech service provided. Specifically, we find evidence indicating that payments infrastructure plays a more important role in the usage of digital payment services, whereas the development of credit information systems is more relevant for the usage of digital lending services.

Second, our results show that the distinction between incumbent banks and fintech companies is particularly important when exploring the potential drivers of fintech activity. We find a robust negative association between fintech activity and banking system development. Countries with deeper, more inclusive, and more competitive banking systems tend to exhibit lower levels of fintech activity. The indicator on banking development captures aspects related to the potential demand for new fintech providers as well as supply-side constraints, such as potential barriers to entry. On the former, digital financial services may have more opportunities to develop in countries with less developed and less competitive banking systems where the under- and unserved share of the market is relatively large and the cost of financial services tends to be higher. In these circumstances, there is more space for new fintech providers to offer such services more efficiently and at relatively lower cost. On the latter, incumbent institutions may display a stronger anti-competitive behavior in a more concentrated and less efficient banking environment in order to maintain the status quo, thus hindering the incentives for entry of fintech companies. The negative correlation found in this paper suggests that the effects associated with the potential demand in countries less developed banking systems, on average, dominate possible supply-side constraints associated with anti-competitive behavior by incumbents.

Furthermore, whereas the estimations show a negative correlation between fintech activity and banking system development, they also show that fintech activity is positively correlated with capital market development. These correlations stem from the development of digital financial services by institutions other than banks, such as fintech companies. For example, the mobile app data show that downloads of banking apps are strongly positively associated with bank development, whereas they are negatively related to the development of capital markets. The opposite patterns are observed for non-bank app downloads. Overall, the findings suggest that well-developed (public and private) equity and bond markets, which reflect at least in part a more favorable investment climate, could foster the emergence of fintech companies by providing the funding that they need to develop.[8,9] Consistent with this interpretation, many fintech companies indeed cite funding constraints as a barrier to scale-up operations (see, for example, Sahay et al. 2020).[10]

Third, our findings are consistent with a high-quality policy environment as a necessary, but not sufficient condition for fintech development. The degree of fintech activity is consistently on the low end of the distribution in countries scoring poorly on policy indices that capture the existence of legal and regulatory frameworks relevant for digital financial services, whereas it varies widely across countries scoring high on these indices. In fact, there are several

8. Capital markets, especially private equity markets, may also bring other auxiliary benefits—through signaling effects (by providing certification to outside investors as well as potential customers), risk-sharing arrangements (by reducing the risk to other investors), improvements in corporate governance, among others.
9. More developed capital markets may also be associated with the emergence of a specific range of fintech companies providing investment advice, investment products, and portfolio management.
10. Financial intermediaries, such as banks, often find it difficult to evaluate novel activities and typically do not accept as collateral the types of intangible capital that compose a large part of the capital stock of innovative firms.

countries that despite having a supportive enabling policy environment exhibit relatively low levels of fintech activity. Regarding the role of sector-specific rules and regulations, our results show mixed patterns. On the one hand, our results tend to indicate that existence of legislation related to e-KYC are positively correlated with fintech activity. Digital ID and e-signature allow the identification and verification of customers without physical interactions, thus facilitating the registration process of customers and reducing onboarding and transaction costs. If supported by enabling regulations, these frameworks can also help digital financial providers comply with (know your customer) KYC requirements, which aim to prevent the criminal use of financial services. E-money provisions also tend to be positively correlated with fintech activity, though the results are relatively weak arguably reflecting opposite effects on different market participants. E-money provisions create legal certainty, predictability, and transparency by establishing the definition of e-money, types of entities that can issue e-money, and the risk management framework required to issue e-money.[11] Yet, certain restrictions related to institutions and activities embedded in such regulations may also stifle innovation and market entry. On the other hand, the analysis shows a lack of consistency in the empirical link between financial consumer protection legislation and fintech activity, perhaps reflecting diverging effects on consumers and providers. From the consumers' perspective, consumer protection measures (for example, disclosure requirements, data privacy laws, and dispute resolution mechanisms) help build the necessary trust and confidence in digital financial services to support adoption and usage. But at the same time, for financial service providers, stricter consumer protection rules could translate into larger compliance costs and greater legal responsibilities that could discourage them from offering certain products and services, especially more innovative ones. These two opposing effects, which are hard to disentangle with the available data, may be one of the reasons why the results are not statistically significant.

While the analysis in this paper explores indicators capturing best practices for legal and regulatory frameworks to enable fintech activity, in the absence of relevant foundations, countries have likely resorted to alternative approaches in practice. Moreover, different combinations of policy choices adopted to open the markets for competition and foster fintech activity might yield similar results. Such combinations and qualitative improvements therein may not necessarily be fully captured in quantifying these reforms via multidimensional indices explored in this paper. Lastly, the relatively short time span of the data analyzed in this paper does not allow us to disentangle the relation of the enabling policy environment and fintech activity at different time horizons. The enabling policy environment could have positive and stabilizing impact on fintech activity in the long term but a negative one in the short term.

Finally, separate, in-depth analyses documented in the appendices offer three key additional findings. First, appendix 3 shows that global downloads of top financial mobile phone applications increased by 41 percent from December 2019 to the pandemic's first peak in April 2020. Moreover, we find some evidence indicating that the stricter social distancing practices (including government implemented containment measures such as lockdowns, quarantines, and travel restrictions) to mitigate the spread of the coronavirus has amplified the use of digital financial services (DFS). Second, in appendix 4, using our more comprehensive fintech activity index, we confirm and expand previous research that established that countries with more stringent banking regulations exhibited weaker fintech activity, potentially because such regulations leave less arbitrage opportunities for fintech entrants. At the same time, we also find a higher prevalence of bank app downloads in countries with more stringent banking regulations, suggesting in these cases that the digital transformation is driven by incumbents. Third, in appendix 5, we document that remittances costs are lower in corridors with a higher prevalence of digital service providers, suggesting that these actors provide meaningful competitive pressure to traditional providers. We also find evidence that ICT and financial infrastructures as well as enabling policies play an important role to lower remittances costs.

11. In a recent survey, many fintech companies stated that uncertainty or frequent changes in the regulatory environment are more of a constraint than a clear road map with tighter regulation (IMF, 2020b).

The remainder of the paper is structured as follows. Section 2 reviews the literature on fintech development and its enabling factors. Section 3 describes the data and methodology. Section 4 documents the patterns of fintech activity across countries, focusing on the four pillars of fintech activity discussed above (i.e. equity investments in fintech companies, usage of fintech credit, usage of digital payments, and downloads of finance apps). Section 5 discusses the potential enablers of fintech activity (ICT and financial infrastructure, financial sector development, and legal and regulatory frameworks), while outlining the proxies used to capture such factors. Section 6 documents the results emerging from the cross-country analyses of fintech activity and its potential drivers. Section 7 concludes.

2. Related Literature

A nascent, but growing body of research, has started to measure fintech development and explore its drivers, though most studies focus on either the experience of one individual country, or one type of fintech service (such as fintech credit), or a narrow set of drivers (such as the existence of regulatory enablers or the potential for regulatory arbitrage). We discuss below how our findings relate to this existing literature. Closely related to our paper is Sahay et al. (2020), who develop a new index to measure digital financial inclusion and explore a set of potential enabling factors.

A number of existing studies aim at measuring the digital economy more broadly. Most of this work relies on the construction of indices that combine a mix of enabling indicators, usage indicators, and indicators on the impact of new technologies, with many indices covering only a few aspects related to digital financial services and others focusing on the degree of digitization. For example, the World Economic Forum (WEF) developed the Networked Readiness Index, which measures the propensity for countries to exploit the opportunities offered by information and communications technology (ICT). In its latest edition, the index covers technology (including ICT infrastructure), people (how different agents use technology), governance (including aspects of inclusion), and impact (on economy and quality of life). Along the same lines, the Digital Economy and Society Index (DESI), developed by the European Commission, is a composite index that aims to track Europe's digital performance and the evolution of digital competitiveness in its member states. BBVA's DiGix Index has a narrower concept of digitization, focused on demand and supply along six dimensions: infrastructure, costs, regulation, contents, households' adoption, and enterprises' adoption. Another example is the Huawei Global Connectivity Index, which ranks countries according to ICT investment, ICT maturity, and digital economic performance.

Some other studies narrow their focus to digital financial activity specifically, including reports by Accenture, CB Insights, KPMG International, and McKinsey, among others. These tend to use data on private equity investments (including venture capital) into fintech companies to discuss cross-country patterns of fintech development. Others explore the data on fintech credit intermediated through online platforms (Cambridge Center for Alternative Finance, various reports; IOSCO 2017; BIS and FSB 2017). Ernst & Young (2017, 2019) constructed a fintech adoption index that draws on an online survey of digitally active consumers in 28 markets to understand whether they were actually using fintech services on a regular basis. Sahay et al. (2020) introduce a new index to measure digital financial inclusion in payments across 52 developing countries, which captures access to ICT infrastructure and usage of digital payments services.

We contribute to the existing research by leveraging a wide range of data sources and developing a novel country-level index of fintech activity. The index is more encompassing than those in the literature, covering three dimensions of fintech activity: fintech firm creation and growth through the availability of early-stage equity financing; usage of fintech credit and digital payments, currently the most commonly used digital financial services - especially in developing countries; and the usage of mobile distribution channels for financial services. Moreover, we analyze both a composite index and individual indices capturing specific dimensions of fintech activity for a large sample of countries.

There is new but quickly developing research that explores the determinants of fintech adoption.[12,13] Because of data constraints, the more developed strand of this literature is concentrated on analyses of fintech credit. This research has explored the role of financial sector development. Using cross-country data on the volume of lending facilitated by online platforms, several papers find that the size of a country's fintech credit market is negatively related to the competitiveness of its banking system, the depth of the banking system, and the density of commercial banks' branch network (Claessens et al. 2018; Frost et al. 2019; Rau 2019; Sahay et al. 2020). Marketplace lending to consumers is found to be negatively related to financial depth, especially in low-income countries, whereas for the business segment, marketplace lending is greater in countries with lower degree of financial efficiency (Bazarbash and Beaton 2020). Moreover, Haddad and Hornuf (2019) report a negative relationship between the soundness of the banking system and startup formations of fintech companies providing lending services. These findings are further supported with micro-evidence from specific markets and platforms.[14]

Our findings corroborate and expand those in the literature by providing evidence that the negative correlation between fintech credit and financial sector depth and efficiency holds across a broader set of fintech activities (including digital payments) and is robust to the inclusion of a number of additional controls typically not found in other studies, such as those related to the policy environment. Moreover, our results also highlight that it is important to distinguish between incumbent banks and fintech companies. In fact, our results show a positive correlation between banking sector development and bank financial app downloads, indicating that the negative correlation between financial system development and fintech activity does not stem from the development of DFS by incumbent institutions. Furthermore, the existing research does not consider the overall structure of financial systems, leaving unexplored the role of capital markets.[15] Our paper takes a step in filling this gap. Our findings suggest that these markets, especially private and public equity markets, could be an important enabler for fintech activity to the extent that they support the provision of funding that fintech companies need to develop.

Regarding the role of infrastructure, some work has indicated that fintech development arguably depends on the availability of a supportive ICT infrastructure (for example, widespread access to mobile phones, computer, internet), though this literature is somewhat scarce. Focusing on the volume of investments into fintech companies, Haddad and Hornuf (2019) find that countries witness more fintech startups when the latest technological infrastructure is readily available, and people have more mobile phone subscriptions. Existing studies tend to capture specific aspects of ICT infrastructure, such as access to internet or mobile phone ownership, but do not consider the affordability and efficiency of such infrastructure. For example, Sahay et al. (2020) find that better access to ICT infrastructure, measured by the availability of the internet and mobile phones, is associated with higher usage of digital financial services. Moreover, existing work focuses on analyzing the role of ICT infrastructure as an enabler of fintech activity, leaving aside the potential enabling role of financial infrastructure. For instance, automated clearing houses might facilitate the provision of digital payments, whereas the coverage, scope, and accessibility of credit information might promote the development of fintech credit. Bazarbash and Beaton (2020) is an exception. They explore the relation between the depth of credit information systems and fintech credit. We thus expand this strand of the literature by analyzing a comprehensive set of indicators reflecting the development of ICT infrastructures as well as by exploring the potential role of the financial infrastructures.

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12. See for example Frost (2020) for an overview.
13. A number of indices in the literature aim at measuring a specific set of drivers for the digital economy, but these tend to mix different types of indicators, not all of them capturing just enabling factors. For instance, The EIU Inclusive Internet Index focuses on the enabling environment for the adoption and productive use of the internet. It comprises four main blocks of indicators: availability (capturing the quality and breadth of available infrastructure required for internet access), affordability, relevance (capturing the value of being connected), and readiness (measuring the capacity among users to take advantage of being online). Citi Digital Money Readiness Index has four sub-components that capture the institutional environment, financial and ICT infrastructures, digital money solutions from government and private sectors, and the enthusiasm from consumers and businesses. Two indices constructed by GSMA are arguably an exception to the extent that they focus only on a key set of enabling factors. Specifically, the GSMA Mobile Connectivity Index measures enablers of mobile internet adoption along four dimensions: infrastructure, affordability, consumer readiness, and content and services. The GSMA Mobile Money Regulatory Index captures a set of regulations which can enable the development of scalable mobile money businesses, drawing from indicators related to consumer protection, KYC, infrastructure and investment environment, among others. We explore the data from the GSMA indices where the underlying data were publicly available and added unique value to our analysis on fintech enablers.
14. See for example De Roure et al. (2019), Tang (2019), and Jagtiani and Lemieux (2019).
15. An exception is Haddad and Hornuf (2019), who argue that new fintech companies tend to emerge more frequently in countries with well-developed capital markets, proxying the level of capital market development with GDP per capita. This analysis does not directly measure the degree of capital market development, nor does it explore the role of private equity markets. Another exception is Cornelli et al. (2020), who use aggregate indicators of capital market development in estimations of fintech and big tech credit volumes.

Another potential set of factors influencing the degree of fintech activity explored in the literature relates to the legal, regulatory, and supervisory environments. Using data on credit intermediated through digital platforms worldwide, Sahay et al. (2020) find that higher protection of legal rights is positively correlated with fintech credit. Similarly, Rau (2019) finds that the rule of law, control of corruption, and quality of general regulation in general are positively associated with the volume of fintech credit. The author argues that P2P platforms are often not explicitly covered by financial regulations. While this enables platforms to reduce compliance costs, it also leads to an unlevel playing field vis-à-vis regulated entities and may create new risks, including to consumers, financial integrity, and financial stability. Similarly, Braggion et al. (2018) find that P2P lending in China rose in cities that tightened loan-to-value ratios, consistent with borrowers tapping P2P credit to circumvent these regulations. In the United States residential mortgage market, Buchak et al. (2018) estimate that the higher regulatory burden on traditional banks accounts for roughly 60 percent of the recent growth of shadow banks, including online fintech lenders. Further, a few cross-country studies find that more stringent banking regulation deters fintech credit, suggesting that fintech regulation might be more permissive in jurisdictions where banking regulation is more liberal (Claessens et al. 2018; Frost et al. 2019; Bazarbash and Beaton 2020). Focusing on the volume of investments in fintech companies, Cumming and Schwienbacher (2018) and Navaretti et al. (2017) provide some evidence that venture capital and private equity investments into fintech companies are relatively more common in countries with weaker regulatory enforcement.

Overall, the existing literature on the role of the policy environment for fintech development focuses either on measures reflecting broadly the state of the legal and regulatory landscape or on specific banking sector regulations. This paper, instead, systematically analyzes the potential role of legislation, which aims to capture aspects of the legal and regulatory frameworks more closely related to fintech development. Our findings thus expand and complement those in the literature. Although a stricter regulatory environment for the financial sector might increase compliance costs and therefore deter financial innovation, it could also foster fintech adoption by promoting a safe, sound, and efficient financial system. For instance, stronger consumer protection rules (for example, disclosure requirements, dispute resolution mechanisms) might encourage greater usage of digital financial services by building the necessary trust and confidence in fintech providers. Another example is the existence of e-money laws, which might provide legal certainty, predictability, and transparency regarding the issuance of e-money, thus facilitating the emergence of a new, innovative, and secure payment instrument. In addition, certain regulations could help create a supportive infrastructure for the provision of fintech services, such as digital ID and e-signature legislation.

3. Data and Methodology: General Considerations

A fundamental challenge in studying fintech activity is that there is no standard, widely accepted definition of "fintech" and the specific technologies, providers, or financial services or products the term encompasses.[16] Hence, measuring fintech activity is not straightforward. Moreover, supply side data are scarce as several of the new fintech activities still lie outside the regulatory and supervisory perimeter, and are therefore not subject to reporting requirements. From the demand side, cross-country surveys offer important insights, but they are relatively infrequent and have only recently begun to add questions related to digital financial services.

In light of these data challenges, we tackle the measurement of fintech activity from several angles, focusing either on developments within different types of financial products (for example, digital payments, digital lending, digital remittances, among others) or on developments across financial service providers (contrasting traditional financial service providers with fintech companies).[17] In addition, we investigate the role of potential enablers of digital transformation in financial services to take hold. Specifically, we analyze whether fintech activity is related to basic foundational characteristics (for example, ICT and financial infrastructures, the degree of economic development, demographics), the development of the financial system (for example, banking sector, capital markets), and the policy environment (for example, legal and regulatory frameworks for digital financial services).

To identify patterns of fintech activity and characterize its enabling factors, we leverage a wide range of data sources, including some novel data on mobile app downloads. In the following sections, we provide a detailed description of the different dimensions of fintech activity, its potential drivers, and the main data examined in this paper. Appendix 2 describes some of the data limitations. It is worth pointing out upfront that many of the data analyzed in this paper are based on confidential surveys (of households, firms, or national/regional government authorities) with limited or no time-series coverage—for example, this is the case for some elements of the World Bank Global Findex survey or the World Bank Global Payment Systems Surveys (GPSS). The timing that different surveys were undertaken is typically not aligned—for example, some surveys reflect information from 2017, others in 2018, and so on. This precludes a causal analysis of "pre-conditions" that exploits the time series dimension of the data. In addition, the effects of some of the potential fintech drivers may take years to materialize.

Hence, our analysis focuses on the cross-sectional variation of the data. For some variables, the sample is quite comprehensive, covering over 180 countries.[18] For others, however, the coverage is much more limited (in some cases, less than 50 countries). Moreover, once these different data are merged, the sample of countries for which there are complete records across the different data elements is reduced significantly. We thus face a tradeoff: cover as many

16. While there are a few broad definitions of fintech (FSB 2017, IMF and World Bank 2018), they do not easily translate into a statistical measure of fintech activity.
17. We do not focus on the direct measurement of developments in technologies that underpin digital financial services, such as distributed ledger technology, big data analytics, and machine learning. While these may contribute to the creation and delivery of digital financial services, we measure supply and demand closer to the product level. From an enabling perspective, we assume these technologies can cross borders and could be applied across countries, provided there is no regulatory barrier. Barriers to adopting specific technologies as well as different business models would be one of the means by which the differences in policy environment would have an impact on fintech adoption.
18. In this paper, we use the term "countries" to denote jurisdictions.

different dimensions or drivers of fintech activity as possible and end up with a limited sample of countries, or forgo some comprehensiveness in the analysis to improve the cross-country coverage. In balancing this tradeoff, we focused on obtaining a comprehensive sample of developing countries. As we discuss our results in the following sections, we will highlight the robustness of our findings regarding this tradeoff.

Given the sample limitations imposed by cross-country analyses, we construct indices so as to reduce the large number of individual variables to fewer, compact indicators, a better suited approach for cross-sectional analysis. This approach also allows us to deal with the confidential nature of some of the data explored, giving us room to report broad patterns. First, we construct a novel index of fintech activity across countries, which is composed of four sub-indices capturing different pillars of fintech development. Second, we develop aggregate indices for each potential driver of fintech activity in order to study, and subsequently explain, the cross-country heterogeneity in fintech activity.

To construct these different indices and their sub-components, we start by re-scaling each individual indicator, adjusting for their different measurement units and ranges of variation. To do so, we apply the minimum-maximum transformation, which projects all indicators within a range between 0 and 100 using the following equation:

$$I_c = \frac{x_c - min_c(x)}{max_c(x) - min_c(x)'},$$

where I_c is the transformed value of the indicator and x_c represents the actual value of the indicator in country c. To mitigate the impact of extreme outliers, we set $max_c(x)$ at the 95th percentile of the indicator's distribution.[19] For countries with indicator values above the upper bound (at most 10 countries), the actual indicator value is replaced with the upper bound resulting in an index score of 100.

We then construct aggregate indices for both fintech activity and its enablers as simple averages across their sub-indices.[20] In the absence of well-established priors and to promote transparency, we assign equal weights to all normalized indicators within each index. When constructing these aggregate indices, we also transform each individual indicator such that they all have the same orientation—that is, a higher score always represents a "positive" score.

19. For robustness, we also constructed indices based on the 99th percentile of each indicator's distribution. In practice, an index constructed with the higher threshold would assign the maximum value of 100 to two countries or less. In comparison to the adopted 95th percentile threshold, the higher 99th threshold indices yield relatively stable rankings, but countries tend to be bundled at the bottom of the distribution, with fewer countries at the top. Such uneven distribution affects the relative weight of different sub-indices in the aggregate indices. The results are qualitatively similar to the reported ones and are available upon request.
20. While other, more complex aggregation methods exist (for example, principal components), we believe that simple averages are most transparent and therefore more suitable for the purpose of the paper and given the various data limitations and gaps. This approach also facilitates the replication and expansion of the indices if/when additional indicators become available.

4. Measuring Fintech Activity Across Countries

To document the broad patterns of fintech activity across countries, we develop a novel aggregate index of fintech activity, measured over the 2014-2018 period. The aggregate index aims at capturing aspects of both the supply of and the demand for digital financial services. In light of the data constraints discussed above, we focus on three dimensions of fintech activity that capture four pillars which have sufficient cross-country coverage. Specifically, the index comprises:

- **Fintech firm creation and growth.** We proxy this dimension with an indicator measuring:
    1. Equity investments in fintech companies.
- **Usage of digital forms of common financial services.** In particular, we focus on:
    2. Usage of fintech credit (facilitated by electronic (online) platforms);
    3. Usage of digital payment services by households and firms.
- **Mobile distribution channels.** Given the rapid adoption of mobile devices, we analyze:
    4. Downloads of finance smart phone applications (apps).

As discussed below, these sub-indices have varying scopes of coverage across types of financial services and across financial service providers. A composite index constructed from such distinct sub-components may not reflect well the dynamics within each sub-component. To mitigate the drawbacks of aggregation, we systematically present the results of the analysis for both the aggregate index and its sub-components.

4.1 Equity Investments in Fintech Companies

This first pillar of the fintech activity index focuses on the creation and growth of fintech companies themselves, since most of them are still quite young at this stage. Specifically, we analyze equity financing into fintech companies through venture capital (VC) and private equity (PE) investments. Equity financing is particularly important for young, innovative, high-tech companies, including those in the financial sector. Existing research argues that financial intermediaries, such as banks, often find it difficult to evaluate novel activities and typically do not accept as collateral the types of intangible capital that compose a large part of the capital stock of innovative firms (Himmelberg and Petersen

1994; Hall 2002; Bougheas et al. 2003; Brown et al. 2009; Hall and Lerner 2010; Czarnitzki and Hottenrott 2011). In contrast, equity finance is perceived as better suited for funding innovative, riskier firms because, unlike debt, equity contracts do not accentuate problems of financial distress for firms. In compensation for the risk assumed, equity holders directly benefit if/when the firm succeeds. Consistent with this view, empirical research provides some evidence that more developed equity (but not credit) markets support faster growth of innovative-intensive industries (Brown et al. 2013; Hsu et al. 2014; Brown et al. 2017; Didier et al. 2020). This financing component of fintech activity thus essentially captures the extent to which, in a given country, there is a vibrant financial market adequately supporting the emergence of fintech companies. It thus proxies for the supply side of fintech development.

Our main data sources for this pillar are PitchBook and Crunchbase, both of which contain detailed transaction-level information on equity investments into fintech companies, covering a wide spectrum of fintech-related financial services. Our goal is to capture the overall degree of fintech activity; hence, we aggregate these investment flows over the 2014-18 period to obtain the stock of investments into fintech firms.[21] In particular, we construct the following three indicators:

i. Value of VC and PE investments in fintech firms, accumulated over the period 2014-18, measured as a percentage of GDP in 2018;
ii. Number of fintech companies that received PE and VC equity investments during 2014-18, scaled by total population in 2018;
iii. Stock of fintech companies as of December 2018, scaled by total population.

After rescaling these three indicators, we aggregate them into an index capturing equity investments in fintech companies.[22] This index covers 157 countries from all geographical regions and across all income groups (figure 2, panel A). The data show that equity investments in fintech companies are particularly large in financial centers, such as Hong Kong SAR, China, Singapore, the United Kingdom, and the United States. Offshore financial centers also appear at the top of the distribution, with countries such as Cayman Islands, Liechtenstein, and Malta among the top 10. Among developing countries, China, India, and South Africa make it to the top 35. It is also worth highlighting the high ranking of Kenya, Ghana, and the Philippines; despite their relatively low level of financial and economic development, they rank 45th, 54th, and 58th respectively.

4.2 Usage of Fintech Credit

This second pillar of the fintech activity index aims at measuring usage of fintech credit. However, these data are not available for a large set of countries. Many of the fintech credit providers are not regulated and therefore not subject to regular reporting requirements. In addition, the standard reporting requirements for more established, regulated financial institutions are not well-suited to separately capture their provision of digital financial services. For instance, it is hard to identify digitally originated loans extended by banks, or the extent to which their loan underwriting and processing has migrated toward newer technologies.

In light of these data limitations, to construct this pillar, we focus on cross-country data on the value of fintech credit facilitated by electronic (online) platforms that match borrowers with lenders (investors) and are not operated by commercial banks. This pillar thus covers a single type of financial transaction (fintech credit) across

21. Because these are flow measures, focusing on a shorter, more recent time period would not necessarily capture the early stages of fintech development in some countries. Hence, we opted for a longer time series when constructing this sub-index. Moreover, investment flows can vary substantially from one year to the next. Aggregating the data over a longer period smooths out some of these fluctuations. As robustness, we also considered the 2018-19 period. The results are qualitatively similar to the ones reported here.
22. For all three indicators, we exclude offshore financial centers (OFC) for the purposes of rescaling the data. We use the list of OFC as defined by the IMF at https://www.imf.org/external/NP/ofca/OFCA.aspx.

a specific set of financial service providers (electronic platforms). These data were collected through annual surveys of electronic platforms worldwide, capturing both business and consumer credit. These surveys were compiled by the Cambridge Centre for Alternative Finance (CCAF), with academics and industry partners including the World Bank.[23]

While these platforms can vary significantly in design, they all use innovations to interact with customers and process large amounts of customer information. Depending on the specific country and the underlying funding and lending approaches, these platforms are referred to as peer-to-peer lenders, loan-based crowd-funders, or marketplace lenders. The CCAF surveys also include platforms that use their own balance sheet to intermediate borrowers and lenders. A final consideration regards the crowdfunding location, as several surveyed platforms in the sample have borrowers in multiple countries. For these platforms that operate in more than one country, the volume of fintech credit is allocated based on individual borrowers' location, not the lender's location.

Our index of usage of fintech credit is constructed based on a single indicator: the value of total new financing intermediated through electronic platforms, accumulated over the period 2014-17 (measured as a percentage of GDP).[24] The index covers 173 countries from all geographical regions and across all income groups (figure 2, panel B). In contrast with the index on equity investments in fintech companies, the usage of fintech credit index is characterized by a larger presence of low and middle-income countries at the top of the distribution. For example, China and Rwanda feature among the 9 countries at the very top, with an index of 100. It is important to point out that fintech credit volumes remain small relative to the volume of credit provided by the commercial banking sector. For example, the top-2 countries, China and the United States, had about US$350 billion (2.9 percent of GDP) and US$43 billion (0.22 percent of GDP) in total volume of credit through online platforms in 2017, respectively. Moreover, as this usage of fintech credit index focuses on the actual provision of digital financial services within each country, it is not surprising that the ranking of some financial centers (especially offshore financial centers) is significantly lower than those in the index of investments in fintech firms. For example, Hong Kong SAR, China and Luxembourg are ranked 94th and 149th in fintech credit, respectively.

4.3 Digital Payments

The third pillar of the fintech activity index captures the usage of digital payments. Innovations in payments systems have been at the forefront of the rise of fintech in the global financial landscape, typically emerging and developing earlier than fintech innovations in other financial services. The most pervasive "new" technology in payments is arguably the mobile phone, especially the smartphone.[25] Simply having a mobile phone can potentially allow access to mobile money accounts and other text- or app-based financial accounts. Having access to the internet as well further expands the possibilities. In fact, digital payments and a new generation of financial services accessed through mobile phones and the internet has driven the recent progress in financial inclusion (Dermirguc-Kunt et al. 2018). In addition, the usage of digital payments for international remittances purposes can also play a role in reducing costs and increasing transaction speeds—see box 1 and appendix 5.

To construct this pillar of the fintech activity index, we analyze two types of data regarding the usage of digital payments: (i) household surveys and (ii) firm surveys. For the former, we use data from the 2017 Global Findex database. This database is amongst the most analyzed data in the literature on financial inclusion. The data are collected

23. In cases primary data were not available (or where there were discrepancies in reported data), secondary data was used (from public information, annual reports, and press releases). Rau (2019) provides a more detailed description of the data collection process.
24. For robustness, we alternatively considered an index comprising two indicators: value of fintech credit through these online platforms to: (a) individuals and (b) business. However, these two indicators have a more limited time series coverage, they are available only for the 2014-16 period. The results were qualitatively similar to the ones reported in the paper and are available upon request.
25. Using digital financial services through mobile phone does not necessarily require sophisticated devices. In Sub- Saharan Africa, relatively simple, text-based mobile phones have powered the spread of mobile money accounts. Similar services are available in other parts of the developing world.

through nationally representative surveys of more than 150,000 adults in over 140 countries, conducted every three years since 2011. We focus the analysis on indicators capturing the usage of mobile phones and the internet to conduct financial transactions, which are only available in the last round of the Findex Surveys conducted in 2017. These data thus cover the usage of a single type of financial product (digital payments) across a wide range of financial service providers.

Regarding the firm survey data, we use the 2015 Merchants Payments database, which provides data on the usage and acceptance of electronic payments by formal micro, small, and medium retailers (MSMRs).[26] These data, however, cover all forms of electronic payments, from electronic fund transfers as well as direct debit or credit transfers, to card payments and to mobile money payment transactions to merchants. They are available at the aggregate level, comprising all these different forms of electronic transactions and do not allow us to focus only on mobile money transactions. Given the different coverage of the two sources of data and our focus on newer digital payment methods, we alternatively constructed an index based only on the household data.

We include the following indicators in our measure of the usage of digital payments:[27]

i. Households

- Share of the adult population that used the internet or mobile phone to access a financial institution account;
- Share of the adult population that used the internet or mobile phone to check their account balance;
- Share of the adult population that made or received digital payments in the past year through mobile phones or the internet;[28]
- Share of the adult population that used the internet to pay bills;
- Share of the adult population that used a mobile phone to pay utility bills;

ii. Firms

- Share of retail sales transactions by MSMRs that are paid electronically (P2B);
- Share of (immediate) supplier payments by MSMRs that are paid electronically;
- Share of wages by MSMRs that are paid electronically (B2P).

Our index on the usage of digital payments covers 139 countries (figure 2, panel C). High-income countries dominate the top rankings of the index. The highest-ranked developing countries are upper-middle income ones: the Russian Federation and Turkey in 34th and 37th place, respectively. Kenya, Mongolia, and Ghana stand out among lower middle- and low-income countries—at 50th, 53th, and 65th positions, respectively. Geographically, countries in Eastern Europe and Central Asia (ECA) and East Asia and the Pacific (EAP) rank on average higher than countries in South Asia (SA) and Middle East and Northern Africa (MENA).

26. See World Bank (2016) for a detailed description of these data.
27. The Global Findex database contains a number of other indicators reflecting access to financial services. We focused on the indicators that more accurately reflect household choices regarding their usage of digital financial services. For example, there is an indicator measuring the share of the population that used the internet to buy something online. However, buying something online does not necessarily mean paying for it online. In many developing countries, people commonly pay cash on delivery for internet orders. Although the Global Findex database has indicators capturing whether online purchases were paid digitally or by cash on delivery, the sample of countries with information for these indicators is rather small. Similarly, we also did not include indicators that measure whether certain transactions were conducted through a financial institution or using "an account", as neither of these measures specifically capture transactions through digital means. Lastly, we also did not include an indicator measuring the share of the population with mobile money accounts due to data coverage—the sample of countries gets reduced significantly if we were to do so.
28. This indicator measures the share of the population that in the past 12 months: used mobile money or mobile phones to make a payment from an account; or used the internet to pay bills or to buy something online; or payed bills, sent or received (domestic) remittances, received payments for agricultural products, received government transfers, received wages, or received a public sector pension directly through a mobile phone.

Box 1. Digital Remittances

Remittances are small-value, cross-border, person-to-person transfers.[29] They are an essential source of income for millions of families across EMDEs, many of whom are poor. In reducing the cost of remittances, policies and regulations and the resulting market conditions can play an important role. When regulators and policy makers create the right enabling environment, remittance service providers can leverage new technologies for the benefit of migrants and their families back home, for example, in the form of cost and time savings. At the same time, the use of technology can help reduce the time it takes to transfer funds. This includes time spent for travel and wait times. In addition, innovative services, such as the use of mobile money for international remittance transfers, can lower fees for sending remittances, which is a large component of the cost. For example, GSMA (2016, 2018) notes the use of mobile technology reduces the cost of remittances in half. Based on the *Remittance Prices Worldwide* (RPW) database, the World Bank reports that as of Q4 2020, the global average cost for digital remittances was recorded at 5.11 percent of the total amount sent, while the global average for non-digital remittances was 6.99 percent.[30]

The speed of an international remittance transaction is another challenge for which innovative models can provide solutions. International remittances take longer to process, compared to domestic transfers, from end to end due to a variety of factors, including differences in daily cut-off times and closing times in different jurisdictions, time required for reconciliations, dispute resolutions and AML/CFT checks to name a few. New technologies can offer innovative ways of overcoming lengthy procedures for these purposes. According to the RPW database, speed of an international remittance transaction varies by the type of the remittance service provider (RSP): while on average the speed of a transaction is 25 hours, it is close to 5 days (69 hours) for banks and less than one day (17 hours) for non-banks (see appendix 5).

Furthermore, recent experiences from COVID-19 lockdowns showed the importance of digital payment instruments for international remittances. Overall, the analysis of data on costs and service availability throughout 2020 indicates that while the availability of cash-based services have gone down, their costs have increased.[31] The results of an econometric analysis of the cost of sending remittances in relation to several corridor-specific, origin-specific and destination-specific characteristics reveal a number of interesting findings and supporting evidence for the availability of services offered by digital MTOs and the cost of remittances: a larger share of services offered by digital MTOs is associated with lower average costs. These results are presented in appendix 5.

4.4 Finance Mobile App Downloads

The development of fintech has not only meant new financial products and services, but also new distribution channels such as the ability to access and use a wide range of financial services through mobile phone apps. Many of these finance apps can also work in environments with slow data connections and low storage capabilities, typical of low-end smartphones, thus making them suitable for a wide range of customers in developed and developing countries alike. In fact, the development of such digital customer-provider interactions has challenged the traditional business model of brick-and-mortar incumbent financial institutions, such as banks, by enabling competition from other providers and diminishing the role of incumbents as gatekeepers to the consumer.

29. See CPMI and the World Bank (2007).
30. See World Bank (2020a). These costs are reported as the average costs of sending $200. A digital remittance must be sent via a payment instrument in an online or self-assisted manner, and received into a transaction account, i.e. bank account, transaction account maintained at a non-bank deposit taking institution (say a post office), mobile money or e-money account.
31. See World Bank (2021).

The fourth pillar of our fintech activity index focuses on these mobile finance apps. The data come from Sensor Tower and cover new financial app downloads by unique users from the two largest mobile app stores, Google Play and Apple App Store. We include in the analysis the full range of apps classified as financial by the app stores, thus covering apps from a wide set of financial institutions (both banks and non-banks) as well as apps providing a wide range of digital financial services. Individual app download data are aggregated at the country level.[32] This novel measure of fintech activity reflects both demand and supply aspects. It captures a demand component to the extent that individuals choose to download new apps and a supply dimension as it reflects the extent to which there are new apps to be downloaded. The app download statistics do not directly capture usage of the downloaded finance apps. Rather, the download data should be interpreted as the number of new (potential) users of individual apps. Nonetheless, downloading an app is a pre-condition for usage, and the two are likely to be strongly and positively correlated.

This sub-index contains two country-level indicators:[33]

i. The total number of finance app downloads, accumulated over 2014-18, measured as a share of the population in 2018;
ii. The total number of finance app downloads as a share of total app downloads—both the numerator and denominator are accumulated over the 2014-18 period.

Although similar, these two indicators capture different aspects of the app download data. When finance app downloads are scaled by population, they proxy not only for the potential usage of finance apps, but also for the overall potential usage of apps more broadly. Our second indicator scales finance app downloads by total app downloads to provide a sense of the relative prevalence and importance of finance apps. The correlation between finance and all app downloads is high at 0.85. That is, countries with larger overall volumes of app downloads will likely also display high volumes of finance app downloads. However, countries with relatively low overall app download volumes could still exhibit high values on the share of financial app downloads. In box 2 and appendix 3, we explore higher frequency data to assess the impact of the pandemic on finance app downloads.

Our measure on finance app downloads covers 84 countries (figure 2, panel D). Both developed and developing countries feature within the top rankings of the index. Among the top-10 countries are some East Asian countries (China, Hong Kong SAR, China, Republic of Korea, and Singapore), Nordic countries (Norway and Sweden), and some in the Americas (Brazil and United States). Although data coverage for African countries is not as comprehensive as for the other measures, Kenya does feature high in this index as the 11th highest ranked country. Despite the heterogeneity at the top of the distribution, there is a high positive correlation between the finance app download index and countries' overall income level. High-income countries have on average higher values than middle-income countries, which in turn, have on average higher values than low-income countries. Countries' income level here may be proxying, at least in part, for smartphone penetration. That is, countries with a greater share of smartphone connections tend to have more app downloads. However, the correlation between smartphone penetration and income level is high (around 0.82) and the analysis does not allow us to disentangle these effects. Although there is an uneven coverage of countries across geographic regions, some patterns emerge. Countries in East Asia and the Pacific (EAP) have the highest values in this sub-index, displaying high levels of both absolute and relative financial app downloads. The few Sub-Saharan African countries in the sample tend to have on average a higher ranking in the aggregate finance app download index than many other developing countries. Although these countries tend to have low absolute values of financial app downloads, arguably reflecting the low penetration of smartphones, the share of financial app downloads is relatively high, thus pushing up their rank in the aggregate index.

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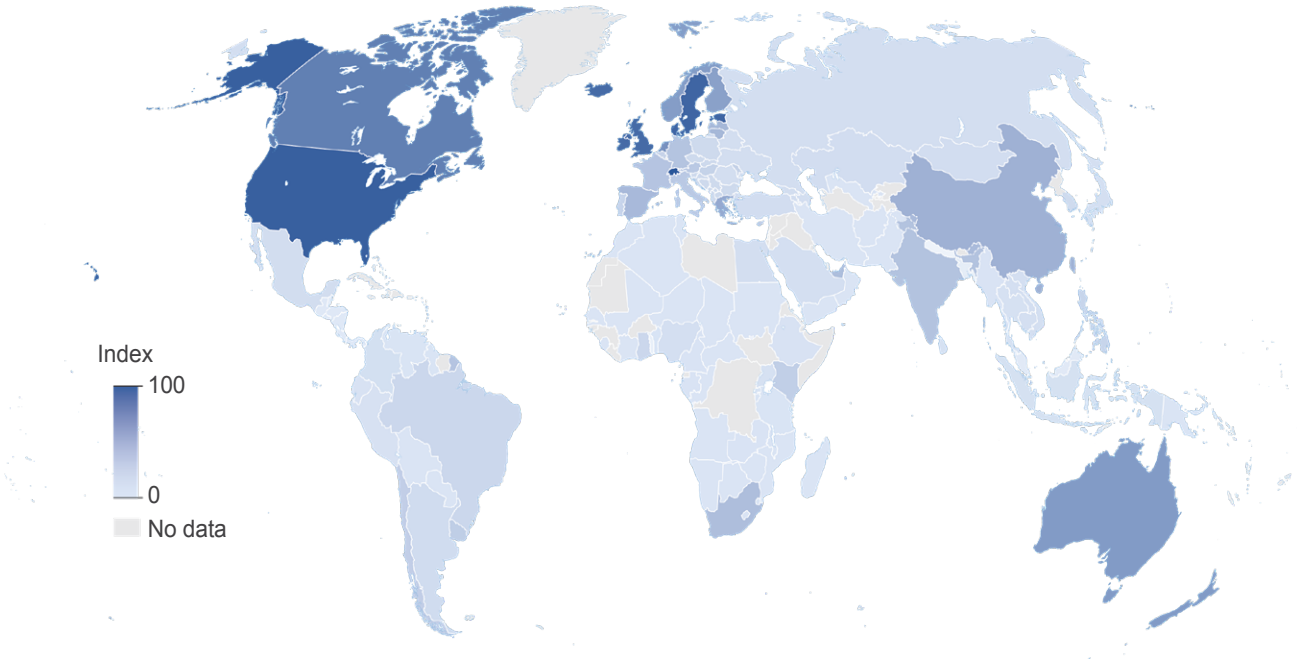
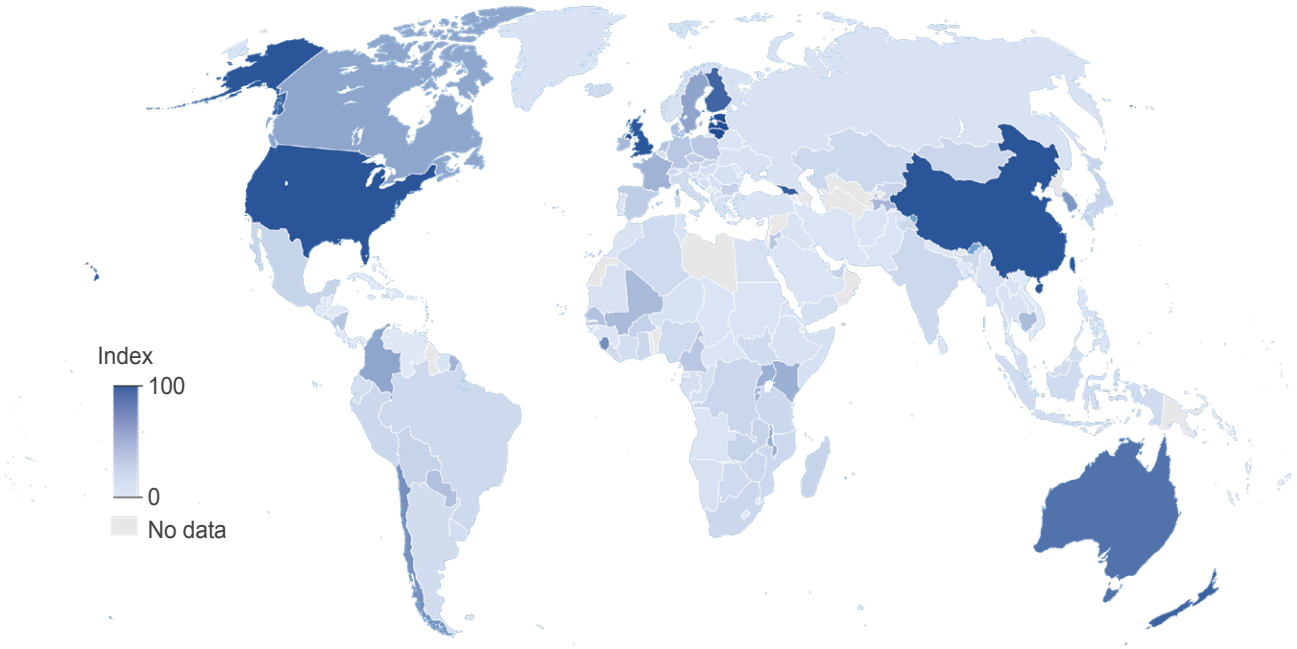
32. The data cover unique new downloads at the account level, tracked by each user's unique identifier in each platform considered. That is, app downloads in different devices (for example, mobile phones or tablets), re-downloads (a case in each a user install, delete, and then install an app again), and app updates do not lead to "double-counting" in the data. It is worth emphasizing that these are flow data, they do not measure the existing installed base (a stock measure). The country-level aggregation of downloads is based on the country of registration for each user's account.
33. See the discussion in Section 4.1 for the reasons we construct an index aggregating data over a 5-year period.

Figure 2A. Equity Investments in Fintech Companies



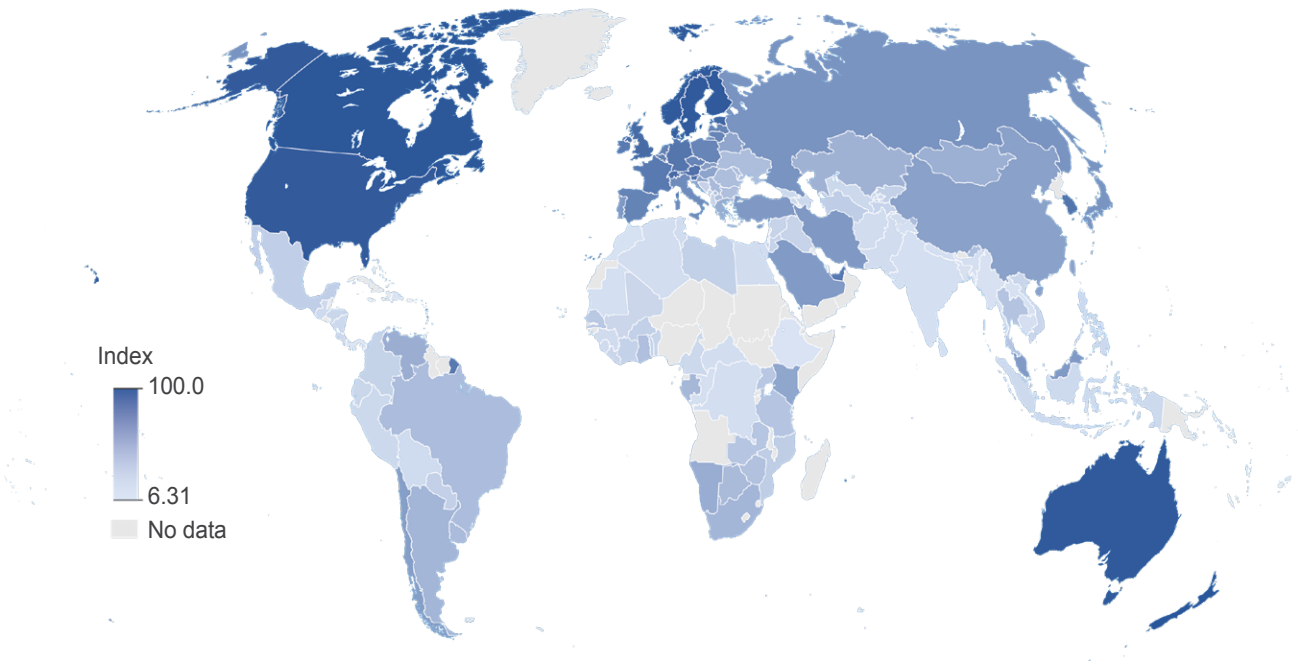
Source: World Bank staff.
This figure shows the index of equity investments in fintech companies across countries. Countries in grey have missing data for the index.

Figure 2B. Usage of Fintech Credit



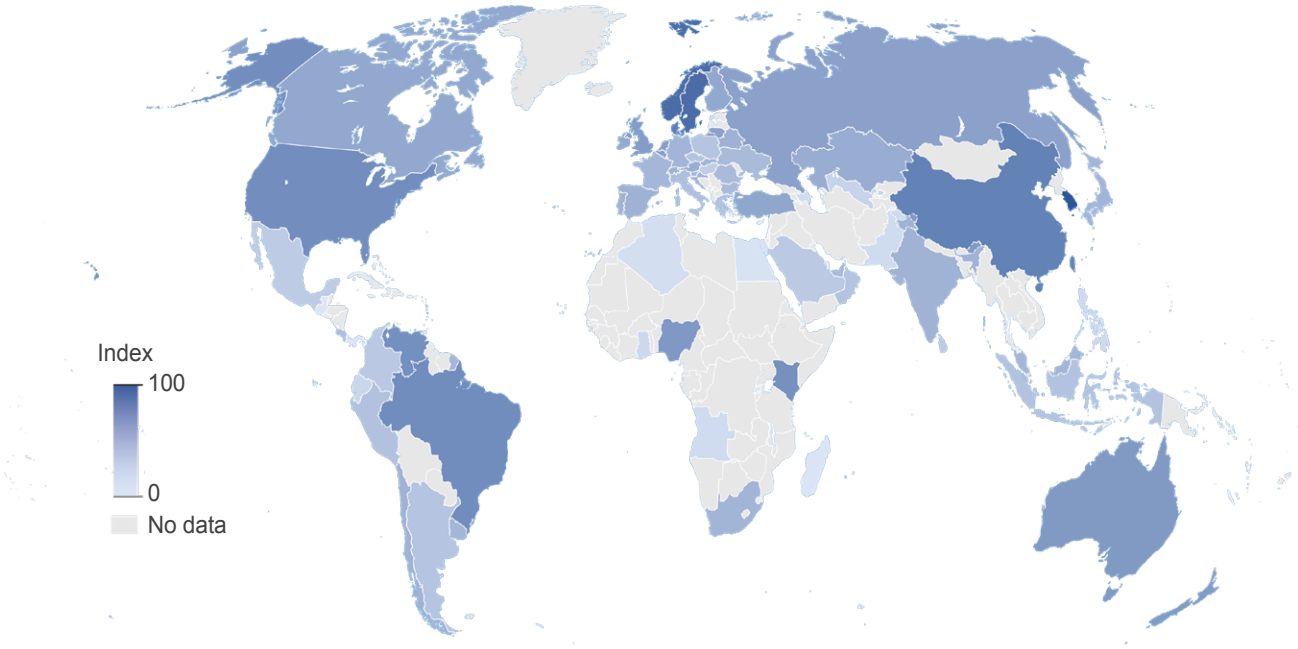
Source: World Bank staff.
This figure shows the index of fintech credit across countries. Countries in grey have missing data for the index.

Figure 2C. Usage of Digital Payments



Source: World Bank staff.
This figure shows the index of usage of digital financial services across countries. This index mostly focuses on the usage of digital payments. Countries in grey have missing data for the index.

Figure 2D. Finance App Downloads



Source: World Bank staff.
This figure shows the index of finance app downloads across countries. Countries in gray have missing data for the index.

Box 2. Financial App Downloads during the COVID-19 Pandemic

The social distancing and other containment measures adopted on a global scale to mitigate the spread of the COVID-19 pandemic have stressed the benefits of DFS. While traditional financial services are predominantly built on cash transactions and face-to-face interactions with financial service providers, digital financial services enable remote, contactless, and cashless payments and transactions. While many have speculated that the pandemic has the potential to accelerate the adoption of DFS, there is little evidence to date that this has indeed been the case. The novel app download data, reflecting the stream of new users of financial apps, can provide some early insights into DFS adoption worldwide during the COVID-19 pandemic.

The analysis in appendix 3 shows that there has been a marked spike in worldwide financial app downloads, especially of non-bank financial apps, during the peak months of the COVID-19 pandemic. The increase is particularly marked for non-bank financial apps. Global downloads of non-bank financial apps increased 45 percent, from an average of about 7 million downloads per day during the last quarter of 2019 (2019Q4) to over 10 million at its peak on April 15, 2020 and around the peak of policy measures taken to constrain community mobility.

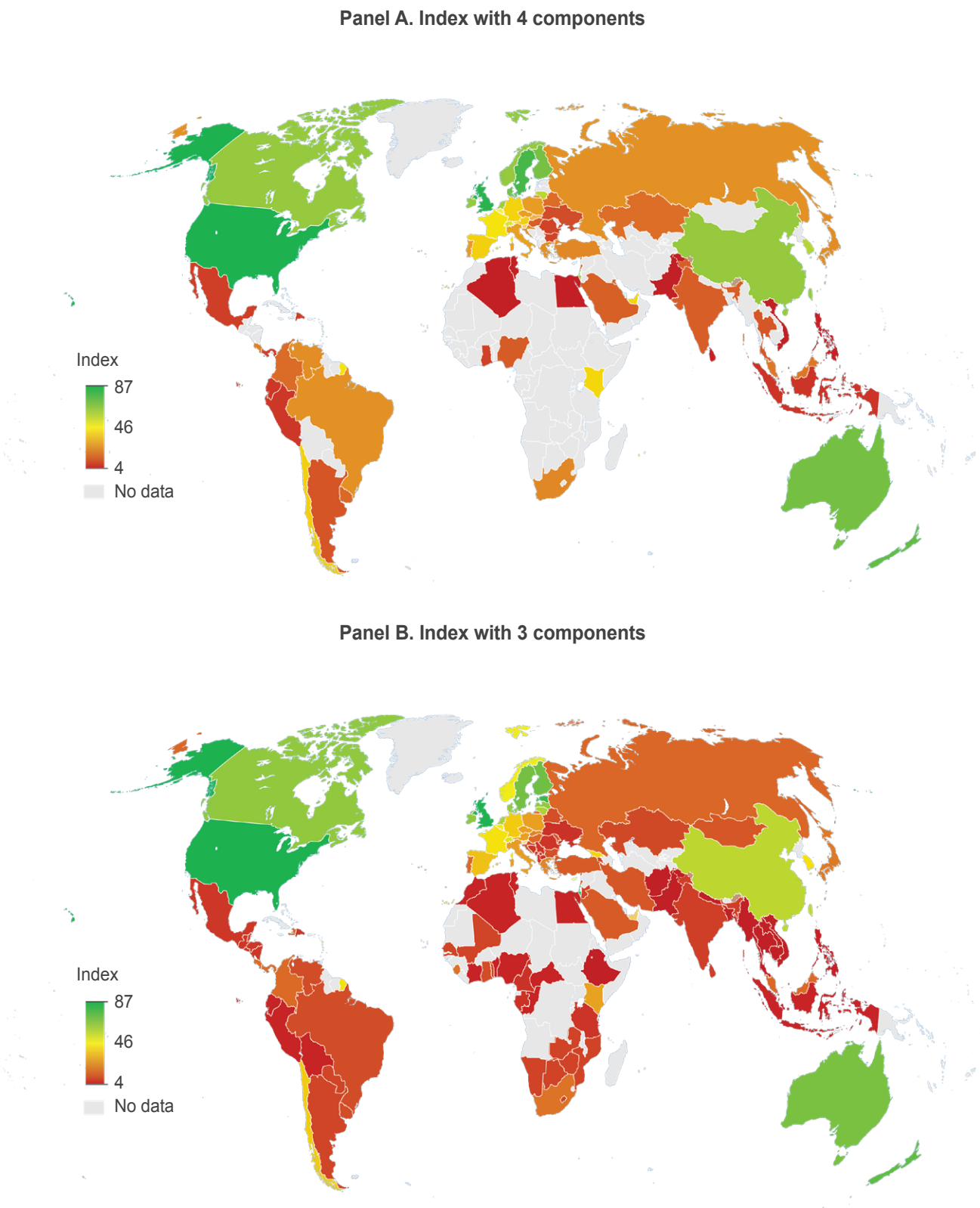
While these aggregate trends mask large cross-country dispersion, the analysis also shows a robust positive correlation at the country level between the growth in downloads of top-100 financial apps since the outbreak of the pandemic and the severity of the impact of COVID-19, even after controlling for GDP per capita and demographic characteristics. Moreover, the estimations indicate that the increase in financial app downloads was related to the stringency of community mobility policies or practices rather than the contagion of the disease itself in a given country.

4.5 Aggregate Fintech Activity Index

The aggregate fintech activity index is calculated as a simple average of all four pillars described above and covers 74 countries. Given the relatively limited coverage of the finance app downloads component, we also consider an aggregate fintech activity index that *excludes* this pillar. The country coverage for this alternative index with three pillars increases to 125 countries (figure 3 and appendix table 1). The two aggregate indices display a correlation of 0.98 with each other, statistically significant at 1 percent, indicating that they yield similar results.[34] The aggregate fintech activity index reflects well its underlying data, displaying positive and statistically significant correlations of 0.76 or higher with each of its pillars.

34. For the rest of this paper, we will focus on maximizing cross-sectional coverage, hence preferring to use the index with 3 components. But we will discuss how the results change for the 4-component index.

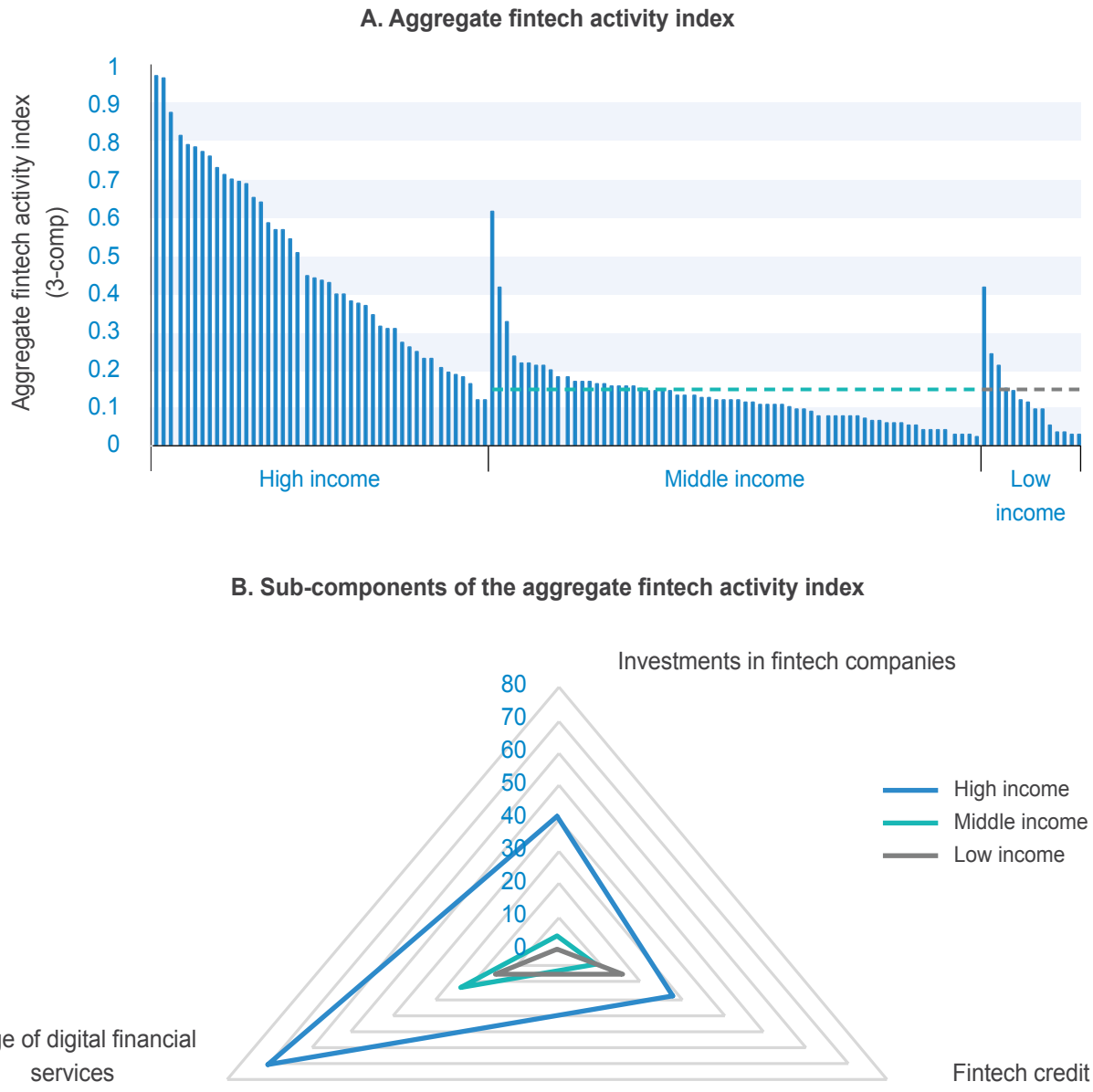
Figure 3. Aggregate Fintech Activity Index



Source: World Bank staff.
This figure shows the aggregate fintech activity index across countries. Panel A shows the aggregate index comprised of four sub-components (equity investments in fintech companies, fintech credit, usage of digital financial services, and finance app downloads). Panel B shows the aggregate index comprised of three sub-components (equity investments in fintech companies, fintech credit, and usage of digital financial services). Countries in grey have missing data.

Our aggregate fintech activity index reveals some robust patterns across income groups and geographical regions. First, fintech activity is positively correlated with countries' per capita income as high-income countries tend to rank higher than developing countries (figure 4). In fact, this dichotomy between high-income and developing countries is observed not only in the aggregate index, but also along all its four pillars (figure 5). The differences are particularly acute for the component on equity investments in fintech companies and the component on the usage of digital payments. Within developing countries, middle-income countries rank, on average, similarly to low-income countries on the aggregate fintech activity index, though there are some differences across the fintech index sub-components: they tend to rank higher on the usage of digital payments and equity investment pillars, while lagging behind low-income countries in terms of usage of fintech credit.

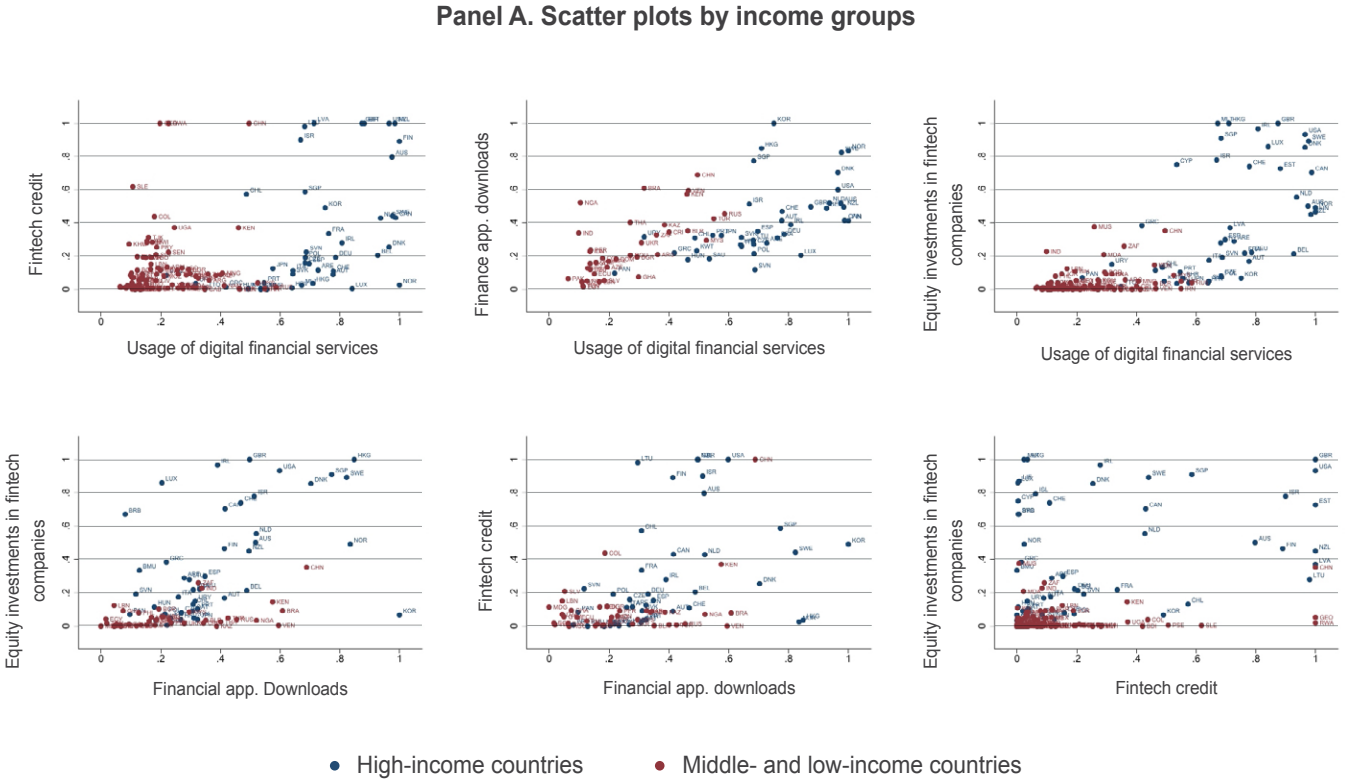
Figure 4. Fintech Activity Index by Income Groups



Source: World Bank staff.
This figure shows the aggregate fintech activity index (with 3 sub-components) across income groups. Panel A shows the average of the aggregate index per income group as well as its cross-country dispersion. Panel B shows the average value of each sub-component of the aggregate fintech activity index for each income group.

The incidence of different forms of DFS is also markedly different depending on countries' level of economic development. There is a positive correlation across all pillars of the fintech activity index for high-income countries, and most correlations are statistically significant at the 1 percent level (figure 5). Moreover, the data are consistent with a pecking order across different types of DFS for high-income countries, where usage of digital payments would emerge first, and would then be followed by usage of fintech credit.[35] At least conceptually, payment and transaction patterns (for example, cash in, cash out) can help establish creditworthiness and spur fintech credit. The top-left scatter plot in figure 5 shows that high-income countries with relatively large volumes of fintech credit also display high usage of digital payments. However, high-income countries with greater usage of digital payments display varying degrees of usage of fintech credit. In other words, the evidence points to usage of digital payments as a pre-condition for usage of fintech credit for high-income countries. Empirically an analogous pattern is not observed for developing countries. For instance, there are countries with relatively high volumes of fintech credit, but relatively low usage of digital payments—Rwanda and Colombia are some examples. In fact, there is no correlation between usage of fintech credit and usage of digital payments for low- and middle-income countries. It is important to notice that we measure fintech credit as lending through electronic platforms, it does not encompass all forms of digital lending.

Figure 5. Correlations between the Sub-Components of the Aggregate Fintech Activity Index



35. These patterns are consistent with the results in Cornelli et al. (2020). They provide some evidence that big tech tend to enter markets first offering payment services, and then afterwards, they introduce other financial services. These results are also in line with survey results in the EY fintech adoption index, which shows that payment services are the most widely known and adopted type of fintech service in a sample of 27 countries (EY, 2017; EY, 2019).

Figure 5 continued

Panel B. Correlation matrix by income groups

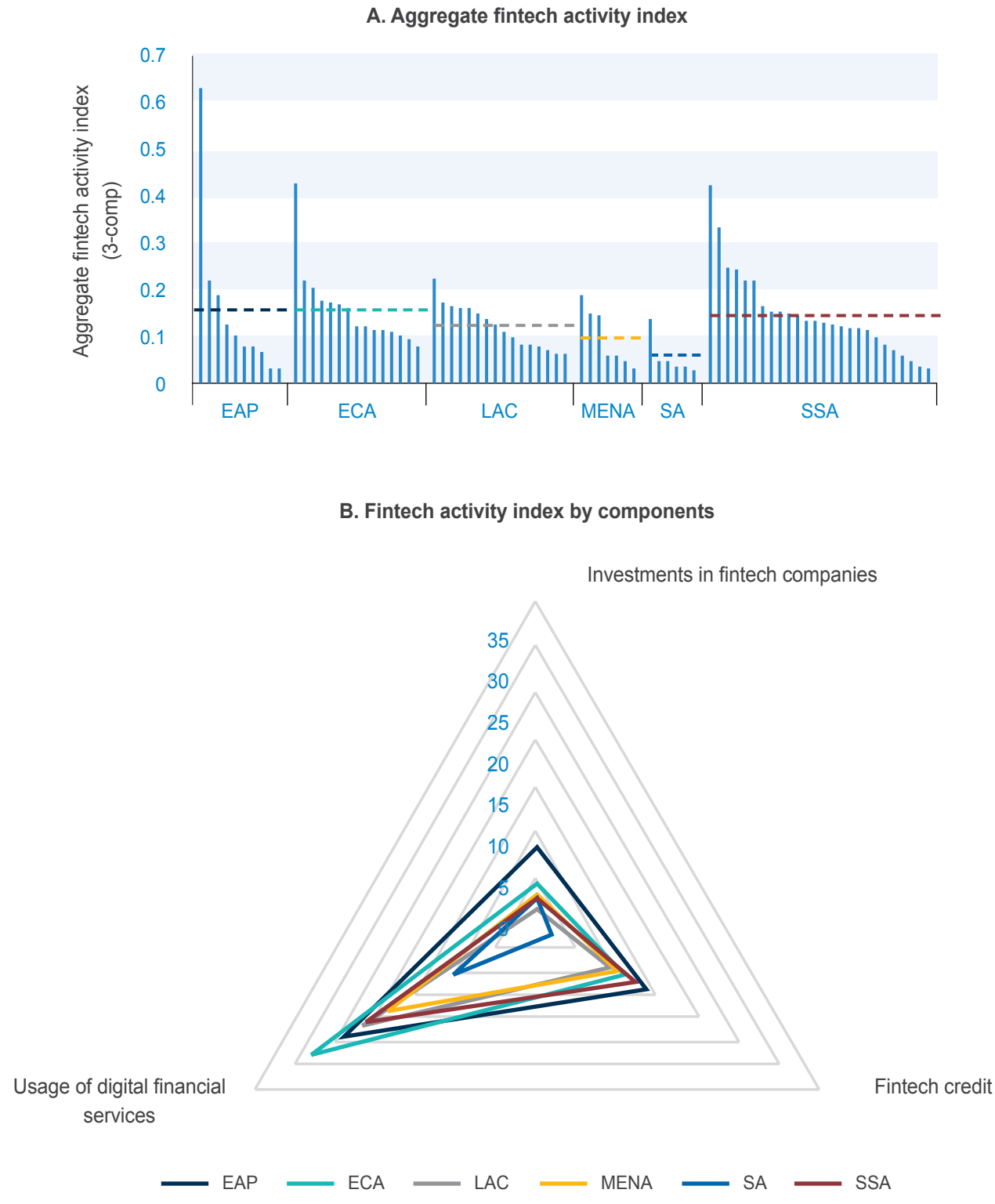
	Cor(usage of fintech credit, usage of digital payments)	Cor(fin. app downloads, usage of digital payments)	Cor(equity investments, usage of digital payments)	Cor(equity investments, fin. app downloads)	Cor(usage of fintech credit, fin. app downloads)	Cor(equity investments, usage of fintech credit)
High-income countries	0.4985*	0.5587*	0.5342*	0.5108*	0.3738	0.2991
Middle- and low-income Countries	0.0335	0.6789*	0.2734	0.4461*	0.3627	0.209

Source: World Bank staff.
This figure shows in panel A the scatter plots and in panel B the cross-country pairwise correlations of the four sub-components of the aggregate fintech activity index. In panel A, high-income countries are shown in blue, middle- and low-income countries are shown in red, In panel B, * denotes statistical significance at 1 percent level.

Second, along the geographical dimension, there is wide dispersion across developing countries (figures 6 and 7). This cross-country heterogeneity is observed at both the aggregate and the four pillars of the fintech activity index. Countries in ECA, EAP, and SSA tend to have greater fintech activity than other developing countries, but a few countries in these regions tend to push up the regional average. Most notably, four SSA countries exhibit the highest level of fintech activity. Specifically, Kenya and Rwanda show not only the highest fintech activity in SSA, they are among the top-5 developing countries (figure 8). Analogously, not all EAP countries exhibit high levels of fintech activity. While China stands out from all other developing countries, Lao PDR and Myanmar appear at the bottom-5 developing countries, along with Ethiopia, Morocco, and Pakistan.

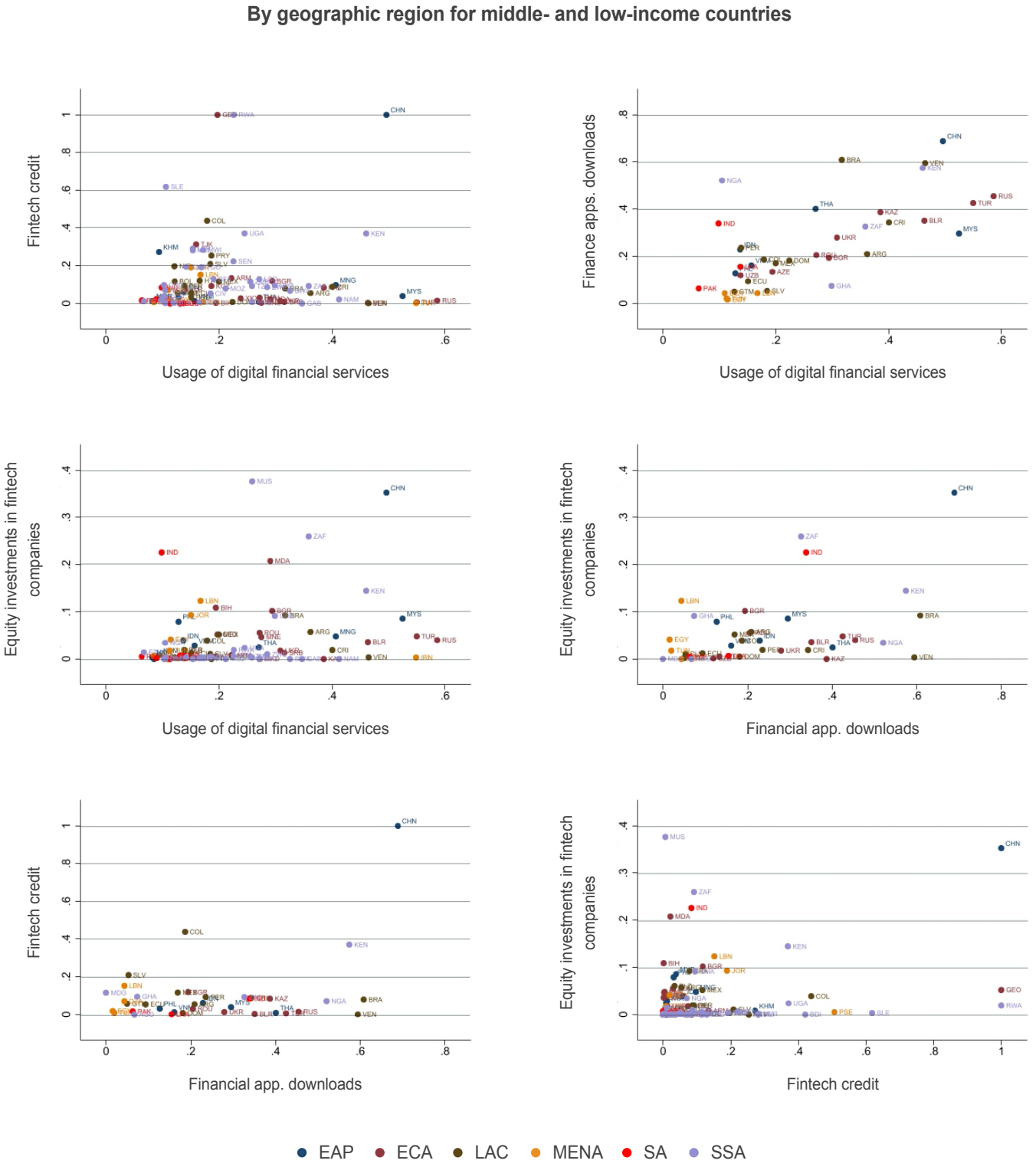
While per capita income proxies for many aspects of a country's stage of economic and institutional development as well as some of its structural characteristics, and thus can help us explain part of the cross-country heterogeneity observed in the data, our aggregate index suggests that other country-specific factors might be at work. For instance, some countries have significantly greater fintech activity than their level of economic development would predict (figure 9). These "outlier" countries comprise both developing (for example, China, Georgia, Kenya, and Rwanda) and high-income countries (for example, Estonia, Latvia, and Lithuania). In the next section, we explore these issues by focusing on possible enablers of fintech activity.

Figure 6. Fintech Activity Index by Developing Regions



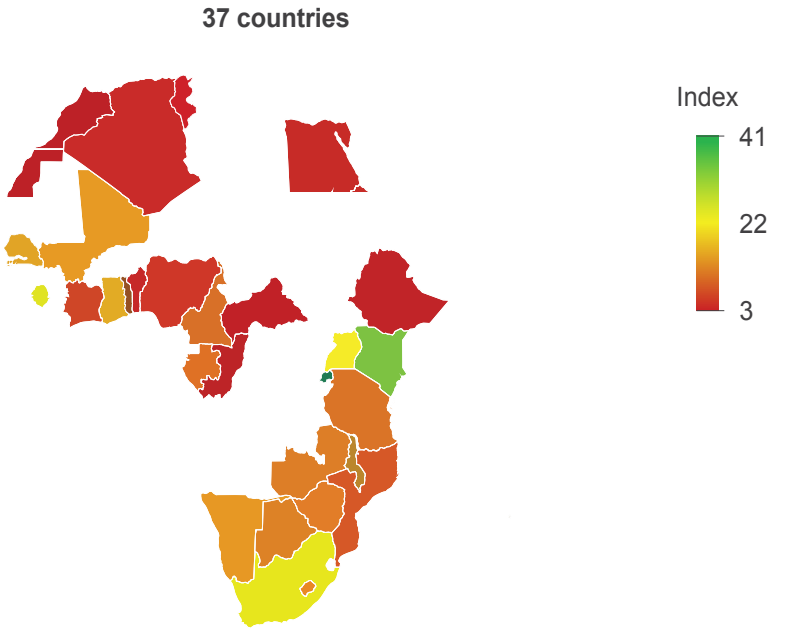
Source: World Bank staff.
This figure shows the aggregate fintech activity index (with 3 sub-components) across geographical regions for low- and middle-income countries. Panel A shows the average in the aggregate index per region as well as its cross-country dispersion. Panel B shows the average value of each sub-component of the aggregate fintech activity index for each geographical region.

Figure 7. Correlations between the Sub-Components of the Aggregate Fintech Activity Index



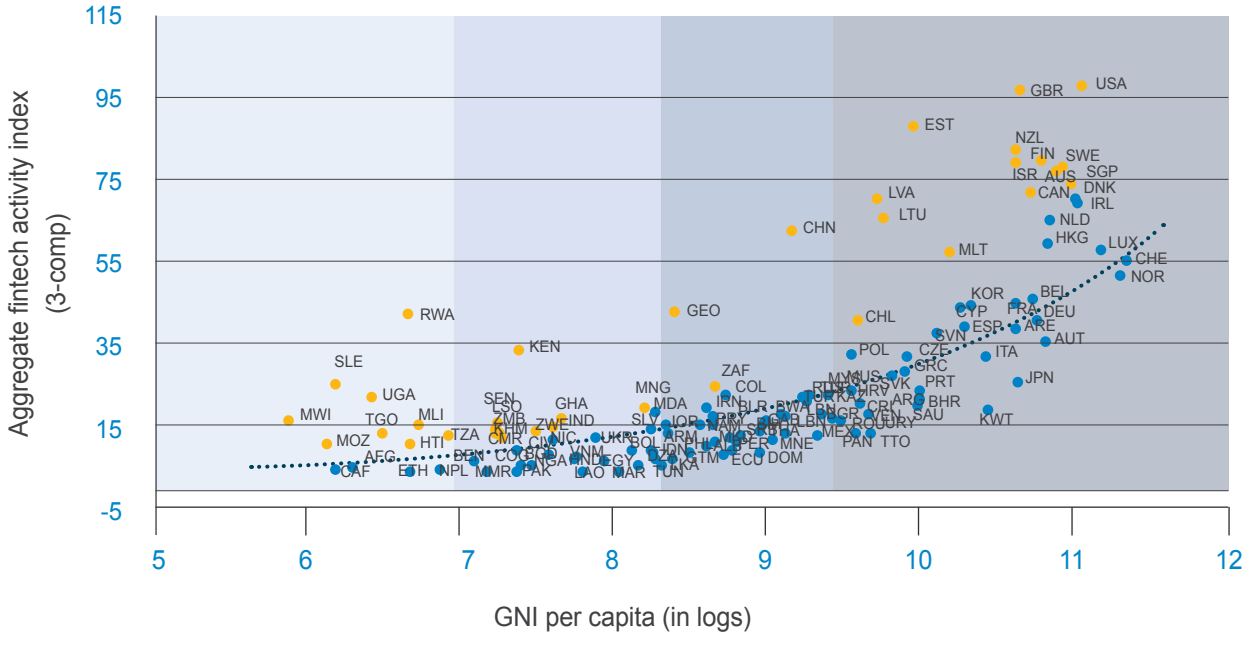
Source: World Bank staff.
This figure shows the cross-country pairwise correlations of the four sub-components of the aggregate fintech activity index. Only middle- and low-income countries are included in the scatter plots.

Figure 8. Fintech Activity in Africa



Source: World Bank staff.
This figure shows the aggregate fintech activity index (with 3 sub-components) across countries with available data in Africa.

Figure 9. Fintech Activity Index and Income per Capita



Source: World Bank staff.
This figure plots the aggregate fintech activity index (with 3 sub-components) against countries' GNI per capita. The shaded blue areas mark the different income groups (high, upper-middle, lower-middle, and low income). The figure also shows an exponential trendline fitting the data. Countries marked in yellow are those for which the aggregate fintech activity index stands above one standard deviation from the trendline.

5. Enablers of Fintech Activity

In this section we explore several economic and technological factors that might impact fintech development. Why do some countries exhibit greater fintech activity than others? In which dimensions are these countries different? Identifying these drivers helps us not only understand the current patterns, but also assess how to foster fintech development. In the diagram above, we presented a simple framework to illustrate the guiding principles and hypothesis underlying the analysis in the rest of this paper. Specifically, we consider three dimensions of over-arching enabling factors of fintech activity:[36]

1. **Basic foundations.** This dimension encompasses both ICT infrastructure as well as financial infrastructure (for example, credit information systems). This dimension also covers the level of economic development and demographics.

2. **Financial sector development.** This dimension captures financial depth, efficiency, and inclusion and distinguishes between the banking sector and capital markets.

3. **Enabling policy environment.** This dimension covers the existence of sector-specific regulation and supervision related to digital financial services (for example, regulations related to e-money, e-KYC, and digital consumer protection).

By themselves, each block of enablers is not enough. For example, being able to fully leverage ICT and financial infrastructures to enable fintech activity depends on a wider range of policy actions and societal characteristics. Overall, these three dimensions interact, co-evolve, and may reinforce each other to foster (or impede) fintech development and adoption.

5.1 Basic Foundations

Some factors may impact all forms of financial services. These include a country's level of economic development, its size, and its demographics, among others. GDP per capita is likely to proxy for many aspects of a country's stage of development, including the quality of its legal and institutional environment as well as overall macroeconomic stability. Hence, we include the log of GDP per capita as a control variable in all estimated regressions.

5.1.1. Infrastructure

Infrastructure, broadly defined, is one of the basic foundational aspects of fintech development. We focus on both the readiness of the ICT infrastructure, which underpins the development of digital financial services, and the state of the financial infrastructure, which supports the development of these services. For example, access to the latest technologies

36. In total, we analyze 49 individual indicators distributed across the three groups of enablers (see appendix 1 for more details).

enables new financial service delivery mechanisms that can potentially help reach unserved customers and reduce overall transaction costs. It can also help reduce the costs associated with collecting and processing information which is essential for the provision of credit (Carletti et al. 2020).

F**intech innovations are highly dependent on widespread access to internet and mobile phone ownership, which in turn, depend on the existence of more basic infrastructure elements such as a reliable power supply.** But ICT infrastructure is not just about availability and access, fintech customers would also benefit from high-quality, reliable, efficient, and affordable networks. Under-development of ICT infrastructure along any or all of these dimensions could hinder fintech development. We thus construct a composite ICT infrastructure index made up of four main categories of indicators (sub-indices), mostly sourced from International Communication Union (ITU) and measured as of 2017-2018, as outlined below:

- ICT infrastructure index:

  i. Availability:

     1. People with access to electricity, as a percentage of population;
     2. Secure internet servers, measured per 1,000,000 inhabitants;
     3. Mobile network coverage (any network type), as a percentage of population;
     4. Mobile network coverage (at least 4G networks), as a percentage of population;
     5. Availability of latest technologies index, from the World Economic Forum;

  ii. Usage:

     6. Mobile-cellular subscriptions, measured per 100 inhabitants;
     7. Fixed broadband subscriptions, measured per 100 inhabitants;
     8. Mobile internet subscribers, as a percentage of population;
     9. Mobile phone ownership and internet access, as a percentage of population;

  iii. Affordability (higher values lead to a lower score):

     10. Cost of 500mb data, as a percentage of GDP per capita;
     11. Cost of fixed-broadband internet, as a percentage of GDP per capita;
     12. Cost of cheapest internet-enabled mobile device, as a percentage of GDP per capita;
     13. Herfindahl index of connections across mobile network providers;

  iv. Efficiency:

     14. International internet bandwidth per internet user (bits/s);
     15. Average mobile broadband download speed index;
     16. Average mobile broadband upload speed index.

Since most developing economies remain primarily cash based, in the current stage of fintech adoption, people using (digital) financial services need a safe and reliable physical network that offers basic services such as cash-in and cash-out and account opening. Indeed, this has been shown to be key to the success of digital payments.[37] Therefore, another supportive element for fintech activity is the state of the financial infrastructure, including physical networks to deliver financial services to all, both urban and rural populations, as well as an adequate payments system. In addition to wide-reaching networks of bank branches, ATMs, POS, in many countries, the agent banking model has fostered the expansion of access points. In this model of financial service delivery, financial institutions form partnerships

37. See for example Kendall and Voorhies (2014).

with local entities such as post offices or retail shops to offer basic financial services to customers. Developing efficient and effective payments systems typically involves a complicated mix of infrastructures, networks, and services with both public and private sector investment, and benefit from varying degrees of competition and collaboration, as well as standardization. Interoperability is a key dimension in this regard as it provides some safeguards to ensure a level playing field among service providers.[38] Interoperable payment systems effectively enable the seamless interaction of proprietary acceptance and processing platforms, and possibly even of different payment products, thereby promoting competition, reducing fixed costs, enabling economies of scale that help in ensuring the financial viability of services while enhancing convenience for users of payment services (CPMI and World Bank 2016 and 2020). The consequences of low interoperability are overlapping or limited coverage, sunken investment costs and inefficiency. For instance, restricted access to payment systems, especially by new or non-traditional financial service providers, could lead to the potentially costly and inefficient multiplicity of proprietary networks, thereby hindering the entry of alternative players, and possibly constraining the supply of payment services to users.

The quality of the infrastructure supporting payments' clearing and settlement processes could also affect the adoption of digital payment instruments. Some key infrastructure elements designed to process (including clearing and netting) payment transactions include: an interbank system for retail electronic funds transfers (for example, automated clearing house (ACH)); a payment card processing platform (card switch); fast payments system; and a large-value interbank settlement system (real-time gross settlement system (RTGS)). Overall, both the quality of the payments' infrastructure and the degree of interoperability among payment service providers can foster fintech adoption, particularly regarding digital payments.

The financial infrastructures related to customer information (for example, credit information reporting and sharing) can be another relevant element supporting fintech development. Specifically, credit reporting systems are an essential element of the financial infrastructure. They aim at mitigating one of the major market failures in finance—that of asymmetric information between financial service providers and their customers—by supporting information sharing across financial service providers.[39] They are particularly important in the provision of lending services as they allow an assessment of customers' creditworthiness based on objective criteria, fostering the adoption of credit scoring systems. In some markets, credit reporting also acts as an effective sanction for non-repayment, encouraging a stronger credit culture. For digital financial service providers (and digital lending more broadly) that lack financial transaction data, access to such systems may be key to product development, particularly credit products.[40] Furthermore, there is empirical evidence suggesting that as more credit information becomes available, competition among banks and non-bank financial institutions increases. For example, Dell'Ariccia et al. (1999) show that, to the extent that access to credit information is limited, incumbent banks are more able to exercise some market power and to limit entry of other financial providers. The same reasoning can be extended to digital financial service providers such as fintech companies. Hence, we expect an overall positive association between the scope, access, and quality of credit information systems and fintech activity.[41]

To examine the role of financial infrastructure as an enabler of fintech activity, we construct a composite index capturing: (i) the payments infrastructure, capturing the quality of retail payment systems, interoperability, and agent networks; and (ii) credit information systems, reflecting the extent to which credit information is widely available and shared by financial service providers. Specifically, we use data from the World Bank Global Payment Systems Survey (GPSS) and the World Bank Doing Business Database to construct the financial infrastructure index as follows:

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38. Interoperability is defined as the technical or legal compatibility that enables a system or mechanism to be used in conjunction with other systems or mechanisms. Interoperability allows participants in different systems to conduct clear and settle payments or financial transactions across systems without participating in multiple systems (CPMI, 2016).
39. Aside from simply providing credit information, credit bureaus and registries can offer fraud detection, debt collection, marketing services, and other services to financial service providers.
40. The introduction of "open banking", supported by application programming interfaces (APIs), which, with the consumer's consent, allow for the exchange of transaction data and may enable transaction initiation by third parties, can further help to overcome information asymmetries between incumbents and new entrants and strengthen competition and innovation.
41. However, some fintech and big tech companies possess vast troves of alternative customer data that can help them build customer credit profiles. This potentially reduces their need to access traditional credit information data infrastructures.

- Financial infrastructure index:[42]

  i. Payment systems:

     1. Interoperability of ATMs, where full interoperability means that all payment and cash withdrawal cards issued by banks in a given country can be used seamlessly (though perhaps at a cost) at all ATMs in that country;
     2. Interoperability of POS terminals, where full interoperability means that all payment cards issued by banks in a given country can be used seamlessly in any POS terminal in that country;
     3. Interoperability of mobile money;
     4. PAFI composite index on the quality of retail payment systems, reflecting the following systems: ACH, card switch, RTGS system, and instant/fast payments' system;[43]
     5. Whether regulations allow agent-based models for financial services provision;

  ii. Credit information systems:

     1. Depth of credit information index, which measures rules and practices affecting the coverage, scope, and accessibility of credit information available through either a credit bureau or a credit registry;
     2. Credit registry coverage, as a percentage of adult population.

5.1.2. Demographics

Demographics may affect fintech activity to the extent that it reflects the potential demand for fintech services, although the direction of the net impact is ambiguous. Younger people not only might be more tech-savvy, but they might also be at the stage in their life where they have a greater need for financial services. One can also argue that this population cohort has not yet developed strong relationships with incumbent financial service providers, being thus more willing to consider non-traditional options as alternatives. The Ernst & Young survey of 22,000 digitally active users across 20 countries shows that in 2017, the fintech adoption rate was 48 percent among those aged 25 to 34 years, compared with only 9 percent for those 75 years and above (EY 2017). Analogously, Bech et al. (2018) find that the use of cash is more common in countries with older populations. However, older people may have more experience in using financial products and services more broadly, and thus may feel more confident regarding using digital financial services. For example, Fuster et al. (2019) find that fintech mortgage borrowing as a share of total mortgage borrowing increases with borrower age, presumably because older borrowers are more familiar with the process of obtaining a mortgage, hence become more willing to borrow online.

In developing countries, financial inclusion tends to be higher in urban areas than in rural areas. For most banks, the fixed costs of setting up branches in rural areas may not be commercially viable as demand is relatively low (and security may be an additional concern). To the extent that this unbanked population would benefit the most from fintech development (for example, access to digital financial services), all else equal (such as ICT infrastructure), we would expect fintech activity to be greater in countries with a greater share of population in rural areas. However, rural populations may be more wary of new technologies and agglomeration benefits (for example, learning by interacting with and observing the usage of technological innovation by peers) may be lower, suggesting that fintech activity would be stronger in urban contexts.

To empirically assess the role of demographics as an enabler of fintech activity, we include the following two variables in the analysis.

42. We also explored indicators capturing the extent of agent networks in financial systems and whether e-money activities were permitted through agents, all of them available from the GPSS. However, the cross-sectional coverage was limited.
43. This indicator is constructed according to the results framework for payment aspects of financial inclusion (PAFI) outlined in CPMI and World Bank (2016, 2020).

- Demographic control variables:

  i. Share of the population between 20 and 39 years old;
  ii. Share of the population in urban areas.

5.2 Financial Development

Technology and infrastructure are only part of the story. To understand fintech development and adoption, we should understand the baseline presented by the traditional or pre-existing financial system. The structure of financial systems and their overall level of development can affect fintech activity (and be affected by it) through various channels, some of which might work in different directions. To analyze these different effects, we examine separately the development of banking systems and the development of capital markets (encompassing bond and equity markets).

On the one hand, an index of banking system development would be a rough proxy of potential demand for new fintech providers. A more developed banking system may provide fewer opportunities for new financial service providers, such as fintech companies, to enter the market and grow. A more developed banking system usually goes hand-in-hand with greater access to finance for both firms and households, and therefore reduces the opportunities for new financial service providers wishing to enter the market, such as fintech companies (Sahay et al. 2020; Frost et al. 2019). The argument applies for both the extensive (i.e. unbankable) and the intensive (i.e. underserved) margins. The financial needs of both firms and households are more likely to be met in countries with deeper and more competitive banking systems. The incentives for fintech development would thus be greater where banking systems are relatively uncompetitive and hence more profitable, and new entrants (such as startup fintech companies) can more easily increase efficiency and lower the costs of financial services.

On the other hand, an index of banking system development would also capture the potential barriers to entry for new fintech providers. For instance, incumbent institutions may display a stronger anti-competitive behavior in a less competitive banking environment in order to maintain the *status quo*. This in turn could hinder growth opportunities for new fintech entrants. Hence, the incentives for entry of fintech companies in such circumstances would be relatively low, especially because new entrants would generally lack the economies of scale and the associated risk diversification advantages of incumbent institutions.[44] Moreover, incumbents in competitive markets might feel some pressure to innovate and adopt fintech solutions themselves. Indeed, most incumbents indicate that digital transformation is a strategic priority (Fintech Market Participants Survey). Overall, greater access, depth, and efficiency of banking systems will influence the potential demand and supply of digital financial services.

Capital market development can affect the supply side of financial service provision, especially the emergence of new fintech companies by providing (directly or indirectly) the funding that these companies need to develop. As discussed in Section 4, venture capital and private equity markets may be particularly well-suited to directly fund such fintech companies. While small business financing (including those in the financial sector) generally does not take place through traditional public equity and bond markets, these traditional markets can provide a supportive environment for the development of the venture capital and private equity industries, and therefore, indirectly support the emergence of fintech companies. For instance, active stock markets generally provide an exit strategy to venture capitalists through the initial public offerings of successful companies. In fact, highly successful fintech companies that quickly gain scale and graduate from early equity investments, such as the so-called “unicorns”, might rely directly on capital market financing. Similar arguments can be made on the role of capital markets for the funding of big tech firms providing digital financial services.

44. Big tech companies are arguably an exception here, typically having the scale and customer base to enter and gain market share even in competitive markets.

Moreover, more developed capital markets themselves expand upon the range of markets in which fintech companies can enter and innovate, such as investment advice or digital distribution of investment products. This is not restricted to developed markets in high-income countries, as demonstrated by the case of m-Akiba in Kenya, a government bond issue purchased and traded via mobile phones. In sum, conditional on the level of banking system development, we expect that fintech companies are more likely to develop in countries with deeper capital markets. Deeper domestic capital markets may also provide opportunities for retail investors to directly participate in markets providing opportunities for fintech services that offer cheaper trading execution and portfolio management and robo-advisory services.

To analyze the relation between financial system development and fintech activity, we construct two indices that measure bank and capital market development separately. The indicators comprising the banking sector development index capture three different aspects of banking systems development, all measured as of 2017: access, depth, and efficiency. The main data sources are Fitch Connect and IMF's Financial Access Survey, WB FinStats Database, and International Financial Statistics. For the capital market development index, indicators are grouped based on the type of financing: public equity and bond markets, and private equity markets (comprising venture capital and private equity). The main data sources for these indicators are Refinitiv's SDC Platinum database and PitchBook, respectively. Specifically, the indices include the following indicators:

- Banking sector development index:
    - i. Access:[45]
        1. Number of commercial bank branches, measured per 100,000 adults;
        2. Number of ATMs, measured per 100,000 adults;
        3. Share of adults with an account at a formal financial institution;[46]
    - ii. Depth:
        1. Private credit by deposit money banks, as a percentage of GDP;
        2. Financial system deposits, as a percentage of GDP;
    - iii. Efficiency (higher values lead to a lower score):
        1. Net interest margin defined as the ratio of net interest income divided by earning assets;
        2. Bank overhead costs, measured as a share of total assets;
        3. Assets of the three largest commercial banks as a share of total commercial banking assets;
- Capital market index:
    - i. Capital markets:
        1. Domestic capital-raising equity issuance volume, accumulated over 2012-16, and measured as a percentage of 2018 GDP;

45. For this component, we also considered the following three indicators constructed from the World Bank Enterprise Surveys: (i) the share of firms with a line of credit; (ii) the share of SMEs that are financially unconstrained; and (iii) SMEs financing gap. In addition, we considered including two indicators from the World Bank GPSS: (i) the number of POS terminals per 100,000 adults and (ii) the number of agents of payment service providers per 100,000 adults. The results were qualitatively similar to the reported ones, but we chose not to report them because adding these indicators to the index reduced significantly the cross-country coverage of the analysis.
46. The share of adults with a financial institution account include respondents who reported having an account at a bank or at another type of financial institution, such as a credit union, a microfinance institution, a cooperative, or the post office (if applicable), or having a debit card in their own name. The data also include an additional 3.93 percent of respondents in 2017 who reported receiving wages, government transfers, a public sector pension (included in 2017 data), or payments for agricultural products into a financial institution account in the past 12 months; paying utility bills or school fees from a financial institution account in the past 12 months; or receiving wages or government transfers into a card in the past 12 months. For more details, see Demirgüç-Kunt et al. (2018).

2. Domestic corporate bond issuance volume, accumulated over 2012-16, and measured as a percentage of 2018 GDP;[47]

ii. VC/PE markets:

1. Value of venture capital and private equity investments (excluding investments in fintech companies), accumulated over 2014-18, and measured as a percentage of 2018 GDP.

5.3 Policy Environment

5.3.1. Legal and Regulatory Frameworks

A high-quality policy environment supports the stability of and trust in the financial system and is conducive to innovation and competition.[48] In particular, legal and regulatory frameworks can be an important enabler of fintech development. Fintech is transforming financial service provision, bringing new services, products, and providers as well as introducing new potential risks to consumers and investors in particular, and to financial stability and integrity more broadly. In fact, an ongoing discussion in policy circles is how financial services regulation would need to adapt to this emerging financial landscape. A widely accepted principle is that regulatory and supervisory frameworks should be proportionate to risks and aim at promoting a level playing field for financial service providers, regardless of their legal form or adopted technologies (CPMI and World Bank 2016 and 2020; Ehrentraud et al. 2020; Restoy 2021).[49] If similar activities and risks are regulated more tightly for incumbent, more traditional service providers—namely, the banking sector—then, fintech activity by non-bank actors could emerge as a response to regulatory arbitrage. In contrast, the existence of regulatory restrictions on types of providers (favoring incumbents) for the provision of certain financial services or a conservative approach to licensing new institutions could hinder fintech activity, especially by entrants.

Going beyond such broad principles, however, is challenging. A priori, the overall effects of the legal and regulatory environment on fintech activity are ambiguous. On the one hand, adopting a highly cautious stance towards fintech services would tend to stifle both innovation and competition by hindering potential market entrants and arguably reducing the supply of fintech services. On the other hand, a very light or lenient approach to fintech may fail to address risks and important market failures, thus threatening the safety, soundness and efficiency of the financial system and potentially leading to inadequate protection of consumers, and even, deterring usage of financial services more broadly.

The challenge for policy makers is, therefore, to design a legal and regulatory framework that is fair and balanced for all stakeholders, maximizing the benefits of fintech development, while minimizing its potential risks (for example, Regulation Note[50]; BIS 2018). The enabling policies cover measures and initiatives that support fintech development, such as those related to digital identities, authentication systems, data-sharing platforms, and the establishment of innovation hubs, regulatory sandboxes, or innovation accelerators. Regarding the mitigation of potential risks associated with fintech activity, legal and regulatory actions focus on consumer and investor protection (such as the safeguarding of customers' funds and data protection laws), and anti-money laundering (AML) and combating the financing of terrorism (CFT).

47. Corporate issuances with less than 1 year of maturity are not covered.
48. Adequate risk management, mitigation of fraud and abuse, and protection of consumer interests are key supervisory and oversight considerations.
49. A survey of 31 countries reveal that the policy responses to new fintech activities have taken various forms, with authorities pursuing a range of approaches when regulating fintech activities. See Ehrentraud et al. (2020).
50. Regulation and Supervision of Fintech: Considerations for EMDE Policymakers (Regulation note) by Tatiana Alonso Gispert, Pierre-Laurent Chatain, Karl Driessen, Danilo Palermo and Ariadne Plaitakis with contributions from Ana M. Carjaval and Matei Dohotaru.

We focus on a narrow set of dimensions of legal and regulatory frameworks: (i) e-KYC frameworks, (ii) issuance of e-money, and (iii) consumer protection. While there are other relevant legal and regulatory aspects that might affect a country's degree of fintech activity, including the legal and regulatory framework for digital credit, we do not cover them because of significant data limitations—either data are not available, or data coverage is restricted to few countries.[51]

Central to the provision of any kind of digital financial service is the ability of financial service providers to accurately identify and verify customers without physical interactions. Digital IDs in particular allow for secure remote identification and authentication of a person's identity, thus enabling access to online and mobile digital financial services. Moreover, they not only facilitate the registration processes of customers, but they also lead to efficiency gains by reducing onboarding and transaction costs and strengthening mechanisms against fraud. In fact, digital identification systems more broadly may help financial providers comply with customer due diligence (CDD) requirements, which aim to prevent criminal activity such as fraud, money laundering, and funding of terrorist groups.[52] A similar argument can be made for digital signatures (or e-signatures), which can be used to identify and verify individuals remotely, thus ensuring that documents have not been altered without authorization. Therefore, it might be easier to launch new digital financial products and services in countries where digital ID and e-signature laws are in place.

One of the major fintech developments, especially in developing countries, has revolved around digital payment services. To make or receive digital payments, customers can use either traditional deposit accounts (which are offered by banks and other authorized deposit-taking financial institutions) or e-money accounts (which can be offered by authorized e-money issuers, such as mobile network operators, banks, and non-banks). While both types of accounts can be used for basic payment transactions, there can be significant differences between them.[53] Central to these differences are the legal provisions applicable to them. Many countries have a dedicated regulatory framework for e-money services in the form of a specific licensing regime or specific regulatory requirements. These provisions create legal certainty, predictability, and transparency by establishing the definition of e-money, types of entities that can issue e-money, and the risk management framework that oversees e-money issuance (Alliance for Financial Inclusion 2019).[54] However, e-money legal provisions could also hinder fintech activity if they were too restrictive, for instance limiting the type of providers that are allowed to issue e-money.

The legal and regulatory approach to fintech development focuses not only on fostering innovation, but also on minimizing the potential risks. Some of the risks of digital financial services fall on retail consumers, including the inadequate handling of personal data, provision of low-quality service (for example, unauthorized transactions), misuse or loss of customers' funds, lack of transparency, and even outright unethical behavior (for example, through abusive fees and contract terms). Legal and regulatory measures tackling these issues usually fall under consumer protection frameworks which are critical in building the necessary trust and confidence in digital financial services to support usage, thereby also fostering emergent fintech activity. We analyze four consumer protection issues that merit special attention: (i) data privacy; (ii) dispute resolution mechanisms; (iii) disclosure requirements; and (iv) safeguarding of customer's funds.

Financial service providers can gather a wide range of customer data, including sensitive personal information and may use them inappropriately or without the customer's permission. For example, unauthorized use of customer data could be aimed at offering unsuitable products to customers with low financial literacy which may encourage poor financial decision making. Customers may also fear that their account transaction history could be used to disqualify

51. We explored a number of other indicators capturing certain aspects of regulatory neutrality, such as: whether non-banks are allowed to issue e-money or to provide certain payment and deposit services; whether non-banks are allowed to contract agents; the range of permitted activities through agents (including e-money); whether basic payment accounts are protected by some form of deposit insurance; among others. However, the cross-country coverage for these indicators is very limited and we ended up with a sample size of less than 50 countries. Because of that, we decided to not include them in the main policy environment index for legal and regulatory frameworks.
52. CDD rules fit within the broader scope of AML and CFT procedures.
53. For example, e-money accounts are often prohibited from paying interest.
54. For example, these provisions typically establish whether non-bank e-money providers can engage in financial intermediation or other banking activities. They may also outline the requirements on the type of assets in which customers' funds can be held.

or reduce the value of benefits received from social assistance programs. Data privacy laws address some of these concerns. They typically specify the type of data that can be disclosed (and to whom) by financial service providers.

Another relevant set of measures relates to dispute resolution mechanisms.[55] Such mechanisms, for example, allow customers to seek affordable and efficient recourse with a neutral third party, such as a supervisory agency or a financial ombudsman. Users of digital financial services are often uncertain about how to address problems with their providers (for example, whom to contact, how to report unauthorized transactions or errors, and how these issues will be resolved). Strong dispute resolution mechanisms are therefore important in preventing customer abuse while providing clarity for clients on how to exercise their rights effectively.

Most fintech developments are characterized by the absence of face-to-face interactions between customers and financial service providers, which increases the potential for miscommunication and misunderstanding of service and product features, such as cost. Moreover, many fintech products and services target first-time customers that typically have limited financial and digital literacy and lack experience with financial services more generally. In this context, strong disclosure requirements could prevent customer abuse. They generally outline the need for transparency on fees, terms, conditions and customer rights associated with financial services plain language requirements (for example, understandable, prohibition of hidden clauses), prescribe standardized disclosure formats, and recourse rights and processes, among others.

The growth of digital financial services, especially because of the emergence of new service providers, has highlighted the risk of misuse or loss of customer funds. Customers are more likely to use digital financial products in particular (and financial products more broadly) in countries where there are safeguards ensuring the safety of their funds. For example, many countries have imposed requirements on the type of assets in which customers' funds are held. Specifically, non-bank payment service providers might be required to keep customers' funds in safe and liquid assets, such as bank deposits in countries with deposit protection schemes. Although the deposit insurance schemes might not directly cover such non-bank financial providers, the fact that the funds are kept in bank deposits might indirectly guarantee their coverage.

All the consumer protection measures described above are discussed from the consumers' perspective. However, for financial service providers, strict consumer protection laws and regulations might translate into large compliance costs and greater legal responsibilities that may discourage them from offering certain products and services, especially more innovative ones. Hence, the relation between consumer protection and fintech development is theoretically ambiguous as it reflects the effects of laws and regulations on both the demand and the supply of fintech services. We investigate which effects seem to dominate empirically.

To summarize, we examine the role of the legal and regulatory framework in fintech development by constructing a composite index that captures a set of the legal and regulatory aspects relevant for fintech development.[56] Specifically, we focus on legal and regulatory aspects related to e-KYC, e-money issuance, and consumer protection frameworks. Specifically, we use data from the World Bank's GPSS and World Bank's Global Financial Inclusion and Consumer Protection survey (FICP), both measured in 2015-2016, to construct the following indices:

- Index on legal and regulatory frameworks for DFS:

    i. E-KYC framework:

55. Internal mechanisms set the standards for complaints resolution and handling by financial service providers (including accessibility, timeliness, and handling procedures). When consumers cannot resolve their disputes with financial service providers bilaterally, they can appeal to external mechanisms to settle disputes out-of-court.
56. This is a departure from the existing literature, which tends to focus on the broad aspects of the legal and regulatory frameworks in a given country (for example, by analyzing Doing Business indicators or Worldwide Governance Indicators).

1. Whether there are e-signature laws or regulations;
2. Whether there are digital ID laws or regulations;
3. Legal recognition of electronic processing of payments;

ii. E-money issuance:[57]

1. Whether legal provisions cover e-money;

iii. Consumer protection:

1. The existence of a general consumer protection law;
2. The existence of a financial consumer protection law;
3. The existence of data privacy laws;
4. PAFI composite index on dispute resolution mechanisms;
5. PAFI composite index on the existence of disclosure requirements;
6. Existence of deposit insurance.[58]

As robustness, we zoom in on some aspects of the legal and regulatory frameworks that can be particularly important for the provision and adoption of digital payments, as discussed in BIS and the World Bank (2016, 2020). Specifically, we construct the following alternative index while adapting the former consumer protection index to avoid the repetition of indicators:

- Payment systems regulatory index:

1. Existence of deposit insurance.
2. PAFI composite index on the existence of disclosure requirements;
3. PAFI composite index on dispute resolution mechanisms
4. PAFI composite index on oversight;
5. PAFI composite index on simplified due diligence for different types of financial service providers.

Lastly, we incorporated into the analysis a measure of whether countries had a regulatory sandbox for DFS in operations. A regulatory sandbox provides some space for experimentation through a targeted regulatory approach, while guiding regulation toward embracing these emerging technologies. Importantly, sandbox programs foster an open engagement between regulators and innovators.[59] To examine the potential role of sandboxes, we use data from the World Bank (2020b):[60]

- Regulatory Sandboxes

i. Whether there is a regulatory sandbox for digital financial services in operation (measured in 2018).

57. We also considered an indicator measuring whether non-banks are allowed to issue e-money. The cross-sectional coverage however was limited.
58. Drawing on the PAFI results framework outlined in CPMI and World Bank (2016, 2020), we also considered a composite indicator reflexing safeguards on customers' e-money funds, including the following indicators from GPSS: (i) whether 100 percent of customers' funds must be kept in accounts at a prudentially regulated financial institutions; (ii) whether a fraction of the money that corresponds to the e-money issued must be kept in one or more prudentially regulated financial institutions; and (iii) whether the types of accounts are clearly specified in the legal framework. However, due to reduced sample coverage, we did not include it in the final index.
59. The development of national strategies can also be an important signaling tool. In a robustness analysis we explored whether fintech activity is greater in countries with national inclusion and financial literacy strategies. The results are quantitatively similar to the reported ones.
60. In another robustness analysis, we also considered several indicators from a survey conducted by the IMF and the World Bank in the context of the Bali Fintech Agenda (IMF and World Bank 2018). Specifically, we constructed a composite index with the following indicators from the survey: (i) whether countries revised their policy frameworks to enable fintech investments; (ii) whether government authorities had set-up a fintech contact point; (iii) whether countries allowed regulatory sandboxes; (iv) whether countries had stablished fintech innovation hubs; (v) whether countries had improved consumer awareness and education; and (vi) whether countries had a national financial inclusion strategy in place. These indicators may provide an index of political will, but the cross-sectional coverage was significantly reduced to 44 (33) countries for the aggregate fintech activity index with 3 (4) components.

6. Main Results

To shed light on the drivers of fintech activity, we conduct a multivariate cross-country regression analysis for the sample of 125 countries with data on our fintech activity index. The baseline regression specification is as follows:

$$Fintech\ Activity_c = \beta_1\ Infrastructure_c + \beta_2 Financial\ Dev._c + \beta_3\ Legal\ Framework_c + \beta_4\ X_c + \varepsilon_c\ ,$$

where $Fintech\ Activity_c$ captures the degree of fintech activity in country c as of end-2018; $Infrastructure_c$ is the infrastructure index comprising the ICT infrastructure and the financial infrastructure sub-indices; $Financial\ Dev._c$ is the financial development index, including the sub-indices for banking development and capital market development; $Legal\ Framework_c$ is the index reflecting whether certain laws and regulations related to the provision of DFS are in place in country c; and X_c is a vector of country-specific controls. Specifically, we include the log of GDP per capita, the share of young adults, and the share of population in urban areas. We estimate one regression for each pillar of the aggregate fintech activity index described in Section 4 (equity investments in fintech companies, usage of fintech credit, usage of digital payments, and finance mobile app downloads). We build on this baseline specification by further disaggregating each set of fintech enablers discussed in Section 5 into their sub-components to better understand the underlying drivers of fintech activity.

Because our dependent variables are indices, we estimate the regressions using a fractional logit model, which allows for the dependent variable to be continuous and bounded between 0 and 1, not binary as in the case of the standard logit model (Papke and Wooldridge 1996). As robustness, we also estimate the regressions using the standard OLS estimator. The results are qualitatively similar to the reported ones.

Once all three dimensions of enabling factors (infrastructure, financial development, and policy environment) are included in the regression analysis, the sample of countries is reduced to about 64 countries (table 1 and appendix table 2). Although this sample is relatively small, capturing about half of the countries with available data for our fintech activity index, it is still representative, comprising countries from all income groups and geographical regions. High- and upper middle-income countries in the sample together capture 51 percent of the GDP and 68 percent of the population within their respective income groups. For low and lower-middle income countries, these shares are 63 and 59 percent respectively. The sample also has representative coverage across regions, although with some limitations. For both SSA and MENA regions, our sample covers a relatively small fraction of the population (about 30 percent), whereas for EAP, ECA, and SA the sample covers more than 70 percent of the population.

Table 1. Country Coverage by Income Group and Geographical Region

Panel A. Worldwide totals			
	No. of countries	Share of world GDP	Share of world population
Total	64	52%	64%
Panel B. Across income groups			
	No. of countries	Share of income group's GDP	Share of income group's population
High and upper-middle income countries	48	51%	68%
Low and lower-middle income countries	16	63%	59%
Panel C. Across geographical regions			
	No. of countries	Share of regional GDP	Share of regional population
EAP	8	71%	74%
ECA	33	83%	81%
LAC	9	47%	50%
MENA	5	23%	34%
SA	2	88%	86%
SSA	7	55%	32%

Source: World Bank staff.
This table documents the representativeness of the sample of countries included in the regression analysis shown in Tables 2, 3, and 4 relative to world totals (panel A), income group totals (panel B), and geographical region totals (panel C). Specifically, it shows how many countries are covered in the regression analysis; the share of these countries in world, income group, or regional GDP; and the share of these countries in the world, income group, or regional population.

The estimation results are reported in table 2 and figure 10 for the aggregate fintech activity index and tables 3 and 4 for its different pillars.[61,62] The results in table 2 are consistent with the graphical analysis described in Section 4. They indicate that fintech activity is generally positively associated with the country's overall degree of economic and institutional development, as proxied by GDP per capita, even after controlling for the share of population in urban areas and the share of young adults. However, GDP per capita is also arguably proxying for many other potential enabling factors—indeed it is highly correlated with several other indicators included in the regression analysis. In fact, once additional explanatory variables are included in the estimations, the coefficient on GDP per capita becomes weaker or even not statistically significant in some regressions.

61. Figure 10 highlights the importance of conducting a multivariate analysis, as some of the bivariate associations between fintech activity and its drivers might not be significant or might even reverse their direction after controlling for additional factors.
62. We report additional estimations for which we expand the sample of countries included in the regressions. To do so, we report some specifications with a more limited set of explanatory variables, which allows us to increase the sample size. In addition, we incorporated additional data for individual countries with missing GPSS data on the indices of infrastructure and the policy environment. These complementary data do not come from the GPSS, but were rather collected in the course of several projects conducted by the World Bank over the same time frame as the GPSS data collection. In addition, we report the estimation results based on the usage of digital payments using only the household data, excluding the data on merchant payments. The results are reported in appendix tables 3, 4, 5, and 6 and are qualitatively similar to the reported ones.

Figure 10. Drivers of Fintech Activity

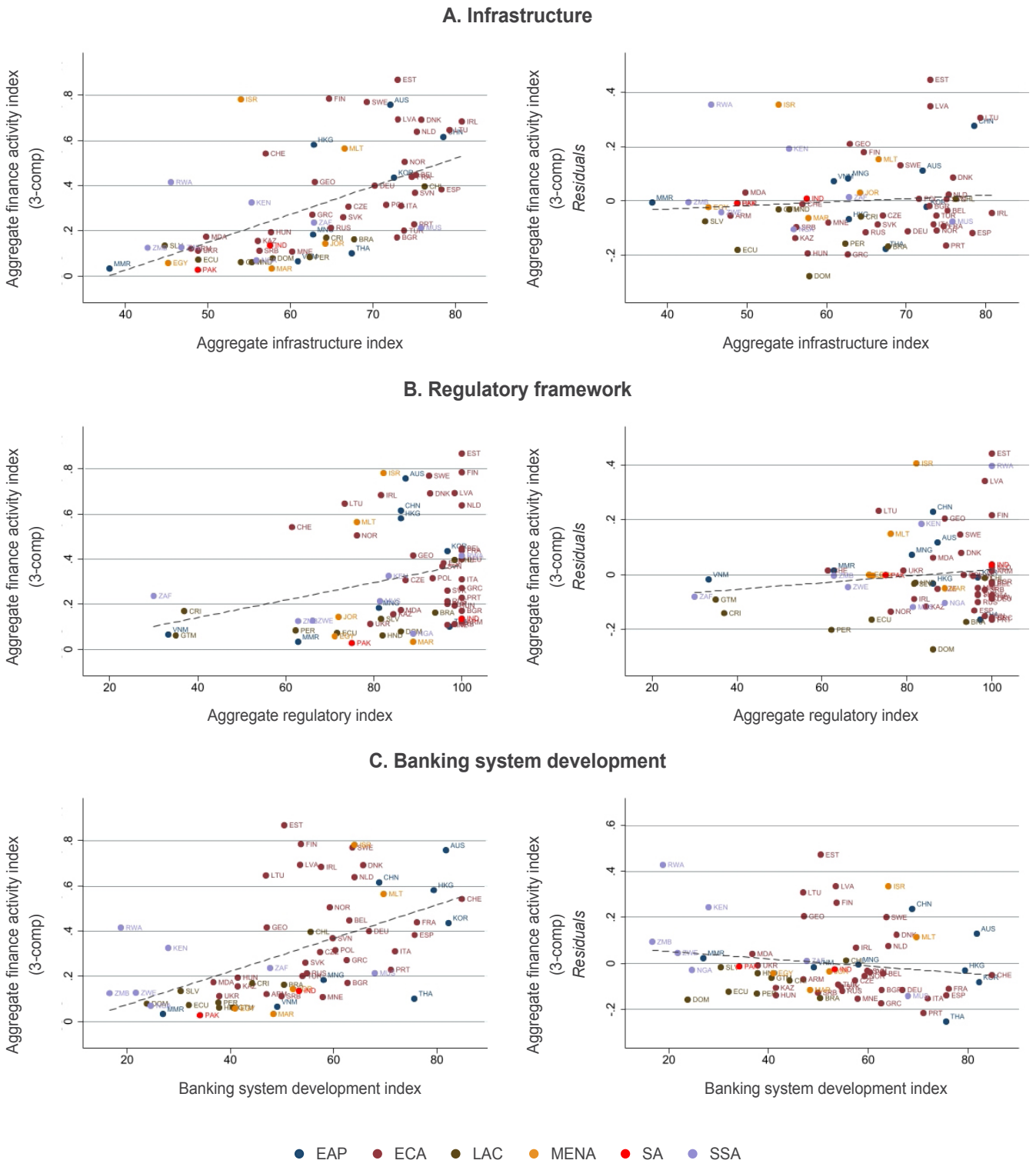
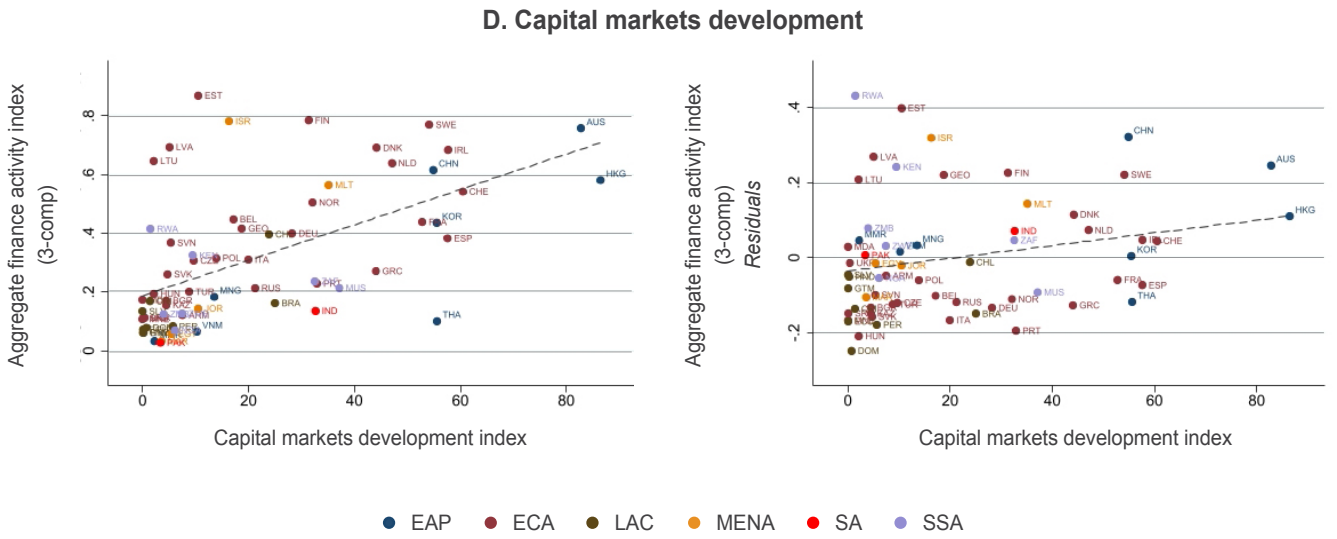


Figure 10 continued



Source: World Bank staff.
This figure shows the cross-country pairwise correlations of the aggregate fintech activity index (with 3 sub-components) and a set of potential drivers of fintech activity: infrastructure index (panel A), regulatory index (panel B), banking system development index (panel C), and capital markets development index (panel D). Graphs on the left show the actual data on the aggregate fintech activity index. Graphs on the right show the residuals from a regression of the aggregate fintech activity index on GDP per capita and the other potential drivers of fintech activity shown in this figure. For example, the regression in panel A includes GDP per capita, the regulatory index, the index of banking development, and the index of capital market development as independent variables. The infrastructure index is excluded from this regression and is thus captured by the residuals. Countries are color-coded according to their geographical region.

Table 2. Regression Analysis: Aggregate Fintech Activity Index

	Index with 4 sub-components						Index with 3 sub-components					
	1	2	3	4	5	6	7	8	9	10	11	12
LN (GDP per capita)	0.779***	0.743***	0.148	0.834***	0.177	0.177	0.711***	0.797***	0.299	0.867***	0.361	0.364
	[0.087]	[0.136]	[0.253]	[0.143]	[0.224]	[0.225]	[0.083]	[0.137]	[0.279]	[0.175]	[0.265]	[0.264]
Share young population	-0.016			0.056	0.032	0.033	-0.039**			-0.006	-0.001	0.001
	[0.013]			[0.041]	[0.039]	[0.042]	[0.015]			[0.040]	[0.033]	[0.036]
Share urban population	0.000			-0.001	-0.000	-0.000	-0.004			-0.006	-0.006	-0.006
	[0.007]			[0.010]	[0.008]	[0.008]	[0.006]			[0.008]	[0.009]	[0.009]
Agg. infrastructure index		0.018		0.018				0.022		0.021		
		[0.018]		[0.017]				[0.018]		[0.018]		
ICT infrastructure			0.057***		0.059***	0.059***			0.056**		0.056**	0.056**
			[0.020]		[0.022]	[0.022]			[0.025]		[0.025]	[0.026]
Financial infrastructure			0.012*		0.012*	0.012*			0.013*		0.012*	0.012*
			[0.007]		[0.007]	[0.007]			[0.007]		[0.007]	[0.007]
Agg. financial dev. index		-0.025		-0.021				-0.043**		-0.044**		
		[0.018]		[0.020]				[0.019]		[0.019]		
Banking system development			-0.037***		-0.035**	-0.035**			-0.044***		-0.044***	-0.044***
			[0.012]		[0.015]	[0.015]			[0.014]		[0.015]	[0.015]
Capital market development			0.024***		0.023***	0.023***			0.021***		0.021***	0.021***
			[0.006]		[0.007]	[0.007]			[0.007]		[0.008]	[0.007]
Agg. regulatory index		0.002		0.006				0.007		0.007		
		[0.004]		[0.006]				[0.006]		[0.007]		
E-money laws			0.010*		0.010**	0.010*			0.008**		0.008	0.008
			[0.005]		[0.005]	[0.005]			[0.004]		[0.005]	[0.005]
Consumer protection index			-0.019**		-0.017*	-0.017*			-0.011		-0.010	-0.010
			[0.010]		[0.010]	[0.010]			[0.010]		[0.011]	[0.011]
E-KYC			0.004		0.004	0.004			0.005		0.005	0.005
			[0.003]		[0.003]	[0.003]			[0.005]		[0.005]	[0.005]
Regulatory sandboxes						-0.000						-0.000
						[0.002]						[0.003]
Observations	74	46	46	46	46	46	125	63	63	63	63	63
(Pseudo) R-squared	0.113	0.103	0.123	0.105	0.124	0.124	0.136	0.130	0.141	0.130	0.142	0.142

Source: World Bank staff.
This table shows the cross-sectional regression analysis of the aggregate fintech activity index and its potential drivers. The first six columns show the regressions based on the aggregate fintech activity index with 4 sub-components, whereas the last 6 columns show the regressions for the index with 3 sub-components. Robust standard errors are reported in brackets. *, **, and *** represent statistical significance at 10 percent, 5 percent, and 1 percent, respectively.

Table 3A. Regression Analysis: Equity Investments in Fintech Companies

	1	2	3	4	5	6	7
Ln (GDP per capita)	1.446***	1.137***	0.621	1.119***	0.562	1.349***	0.802**
	[0.249]	[0.249]	[0.522]	[0.211]	[0.398]	[0.299]	[0.377]
Share young population						0.027	0.057
						[0.076]	[0.077]
Share urban population						-0.014	-0.017
						[0.015]	[0.016]
Agg. infrastructure index	0.005	0.002		0.028		0.024	
	[0.025]	[0.027]		[0.022]		[0.022]	
ICT infrastructure			0.051		0.069**		0.074**
			[0.047]		[0.035]		[0.037]
Financial infrastructure			-0.002		0.011		0.008
			[0.014]		[0.011]		[0.010]
Agg. financial dev. index	-0.052**						
	[0.026]						
Banking system development		-0.041**	-0.047*	-0.055***	-0.060***	-0.059***	-0.062***
		[0.020]	[0.025]	[0.016]	[0.018]	[0.018]	[0.020]
Capital market development		0.036***	0.037***	0.040***	0.041***	0.042***	0.041***
		[0.012]	[0.013]	[0.010]	[0.010]	[0.010]	[0.011]
Agg. regulatory index	-0.005	-0.003	-0.005				
	[0.010]	[0.008]	[0.007]				
E-money laws				0.013	0.012	0.012	0.012
				[0.008]	[0.008]	[0.008]	[0.008]
Consumer protection index				-0.030**	-0.031**	-0.027**	-0.028*
				[0.012]	[0.013]	[0.014]	[0.015]
E-KYC				0.004	0.004	0.007	0.007
				[0.005]	[0.005]	[0.006]	[0.006]
Observations	63	63	63	63	63	63	63
(Pseudo) R-squared	0.247	0.269	0.275	0.284	0.291	0.286	0.295

Source: World Bank staff.
This table shows the cross-sectional regression analysis of the index representing equity investments in fintech companies on the potential drivers of fintech activity. Offshore financial centers are excluded from the estimations. Robust standard errors are reported in brackets. *, **, and *** represent statistical significance at 10 percent, 5 percent, and 1 percent, respectively.

Table 3B. Regression Analysis: Usage of Fintech Credit

	1	2	3	4	5	6	7	8
Ln (GDP per capita)	0.165	0.145	-0.550	0.148	-0.478	-0.575	-0.495	-0.600
	[0.369]	[0.421]	[0.848]	[0.397]	[0.802]	[0.603]	[0.784]	[0.610]
Share young population							-0.054	-0.107
							[0.084]	[0.091]
Share urban population							-0.004	-0.008
							[0.018]	[0.019]
Agg. infrastructure index	0.066	0.065		0.077				
	[0.057]	[0.056]		[0.048]				
ICT infrastructure			0.101		0.101	0.138***	0.098	0.135***
			[0.076]		[0.069]	[0.052]	[0.069]	[0.050]
Financial infrastructure			0.031		0.036*		0.035*	
			[0.027]		[0.022]		[0.021]	
Payment systems infra.						0.011		0.009
						[0.010]		[0.011]
Depth of credit information						0.074***		0.078***
						[0.021]		[0.021]
Credit registry coverage						0.006		0.006
						[0.006]		[0.006]
Agg. financial dev. index	-0.076*							
	[0.043]							
Banking system development		-0.057*	-0.073*	-0.064**	-0.077**	-0.089***	-0.078**	-0.092***
		[0.033]	[0.041]	[0.030]	[0.037]	[0.030]	[0.037]	[0.030]
Capital market development		0.021	0.027	0.022	0.027	0.028*	0.028	0.030*
		[0.018]	[0.021]	[0.018]	[0.021]	[0.016]	[0.020]	[0.016]
Agg. regulatory index	0.027	0.027	0.025					
	[0.017]	[0.017]	[0.017]					
E-money laws				0.017*	0.016	0.018	0.014	0.015
				[0.010]	[0.011]	[0.012]	[0.012]	[0.013]
Consumer protection index				-0.015	-0.014	-0.018	-0.014	-0.019
				[0.022]	[0.024]	[0.021]	[0.026]	[0.021]
E-KYC				0.018	0.017	0.022**	0.016	0.021*
				[0.012]	[0.012]	[0.011]	[0.012]	[0.011]
Observations	63	63	63	63	63	63	63	63
(Pseudo) R-squared	0.085	0.085	0.100	0.101	0.114	0.181	0.117	0.191

Source: World Bank staff.
This table shows the cross-sectional regression analysis of the index representing fintech credit on the potential drivers of fintech activity. Robust standard errors are reported in brackets. *, **, and *** represent statistical significance at 10 percent, 5 percent, and 1 percent, respectively.

Table 3C. Regression Analysis: Usage of Digital Payments

	1	2	3	4	5	6	7	8	9	10
Ln (GDP per capita)	1.083***	1.074***	0.823***	1.076***	0.819***	0.810***	0.723***	0.981***	0.969***	0.946***
	[0.125]	[0.130]	[0.197]	[0.132]	[0.197]	[0.185]	[0.225]	[0.228]	[0.203]	[0.235]
Share young population								0.017	0.039	0.007
								[0.039]	[0.038]	[0.041]
Share urban population								-0.011	-0.009	-0.014*
								[0.008]	[0.007]	[0.008]
Agg. infrastructure index	0.018**	0.017*		0.021*						
	[0.009]	[0.009]		[0.011]						
ICT infrastructure			0.034**		0.037**	0.038**	0.055***	0.038**	0.040**	0.054***
			[0.017]		[0.017]	[0.018]	[0.018]	[0.016]	[0.017]	[0.018]
Financial infrastructure			0.007		0.009*			0.009		
			[0.005]		[0.006]			[0.005]		
Interoperability index						0.001	0.001		0.001	0.000
						[0.002]	[0.002]		[0.002]	[0.002]
Quality of retail payment systems index						0.006	0.007*		0.006	0.006
						[0.004]	[0.004]		[0.004]	[0.004]
Agent network index						0.004**	0.005**		0.004**	0.004**
						[0.002]	[0.002]		[0.002]	[0.002]
Credit information systems index						0.000	-0.000		-0.000	0.001
						[0.004]	[0.004]		[0.004]	[0.004]
Agg. financial dev. Index	-0.039**									
	[0.019]									
Banking system development		-0.030**	-0.035**	-0.033**	-0.038***	-0.034**	-0.051***	-0.039***	-0.034**	-0.053***
		[0.014]	[0.014]	[0.014]	[0.014]	[0.014]	[0.017]	[0.015]	[0.015]	[0.016]
Capital market development		0.011*	0.013**	0.012*	0.014**	0.011*	0.020**	0.014**	0.011*	0.020**
		[0.006]	[0.006]	[0.006]	[0.007]	[0.006]	[0.008]	[0.007]	[0.006]	[0.008]
Agg. regulatory index	0.009**	0.009**	0.007*							
	[0.004]	[0.004]	[0.004]							
E-money laws				0.004	0.004	0.005*	0.002	0.004	0.005*	0.002
				[0.003]	[0.003]	[0.002]	[0.003]	[0.003]	[0.003]	[0.004]
E-KYC				0.005	0.005	0.005	0.006	0.005	0.005	0.005
				[0.004]	[0.004]	[0.003]	[0.004]	[0.003]	[0.003]	[0.004]
Consumer protection index				-0.003	-0.004	-0.007		-0.002	-0.005	
				[0.005]	[0.005]	[0.005]		[0.005]	[0.005]	
Alternative consumer protection index							-0.003			-0.002
							[0.005]			[0.005]
Payment systems regulatory index										
Existence of deposit insurance							0.002			0.001
							[0.003]			[0.003]
Disclosure requirement index							-0.007**			-0.006
							[0.003]			[0.003]
Dispute resolution index							0.003			0.003
							[0.003]			[0.004]
Oversight (risk management) index							-0.002			-0.000
							[0.004]			[0.005]
Simplified due diligence index							0.001			0.000
							[0.002]			[0.002]
Observations	64	64	64	64	64	64	57	64	64	57
(Pseudo) R-squared	0.213	0.213	0.215	0.214	0.216	0.220	0.236	0.218	0.222	0.239

Source: World Bank staff.
This table shows the cross-sectional regression analysis of the index representing the usage of digital payments on the potential drivers of fintech activity. See main text for more details on each indicator. Robust standard errors are reported in brackets. *, **, and *** represent statistical significance at 10 percent, 5 percent, and 1 percent, respectively.

Table 3D. Regression Analysis: Financial App Downloads

	1	2	3	4	5	6	7	8
LN (GDP per capita)	0.373**	0.153	-0.027	0.122	-0.063	0.068	-0.097	-0.040
	[0.168]	[0.156]	[0.323]	[0.152]	[0.324]	[0.337]	[0.305]	[0.309]
Share young population							0.092	0.060
							[0.082]	[0.084]
Share urban population							0.010	0.011
							[0.010]	[0.011]
Total app. downloads						0.003*		0.002
						[0.001]		[0.001]
Agg. infrastructure index	0.021	0.016		0.023				
	[0.017]	[0.016]		[0.019]				
ICT infrastructure			0.026		0.031	0.034	0.035	0.036
			[0.027]		[0.025]	[0.027]	[0.030]	[0.030]
Financial infrastructure			0.006		0.010	0.006	0.010	0.008
			[0.009]		[0.010]	[0.010]	[0.008]	[0.008]
Agg. financial dev. index	-0.020							
	[0.025]							
Banking system dev.		-0.019	-0.023	-0.022	-0.026	-0.032*	-0.017	-0.023
		[0.018]	[0.018]	[0.020]	[0.018]	[0.017]	[0.021]	[0.020]
Capital market dev.		0.028***	0.029***	0.029***	0.030***	0.027***	0.026***	0.025**
		[0.009]	[0.008]	[0.009]	[0.008]	[0.009]	[0.009]	[0.010]
Agg. regulatory index	0.006	0.005	0.005					
	[0.005]	[0.005]	[0.005]					
E-money laws				0.007	0.006	0.005	0.008*	0.007
				[0.005]	[0.005]	[0.005]	[0.005]	[0.005]
Consumer protection index				-0.007	-0.007	-0.007	-0.004	-0.006
				[0.012]	[0.012]	[0.011]	[0.011]	[0.010]
E-KYC				0.002	0.002	0.001	0.003	0.001
				[0.005]	[0.005]	[0.005]	[0.004]	[0.005]
Observations	47	47	47	47	47	47	47	47
(Pseudo) R-squared	0.045	0.074	0.075	0.076	0.077	0.082	0.085	0.087

Source: World Bank staff.
This table shows the cross-sectional regression analysis of the index representing financial app downloads on the potential drivers of fintech activity. Robust standard errors are reported in brackets. *, **, and *** represent statistical significance at 10 percent, 5 percent and 1 percent, respectively.

Table 4. Regression Analysis: Bank vs. Non-Bank Financial App Downloads

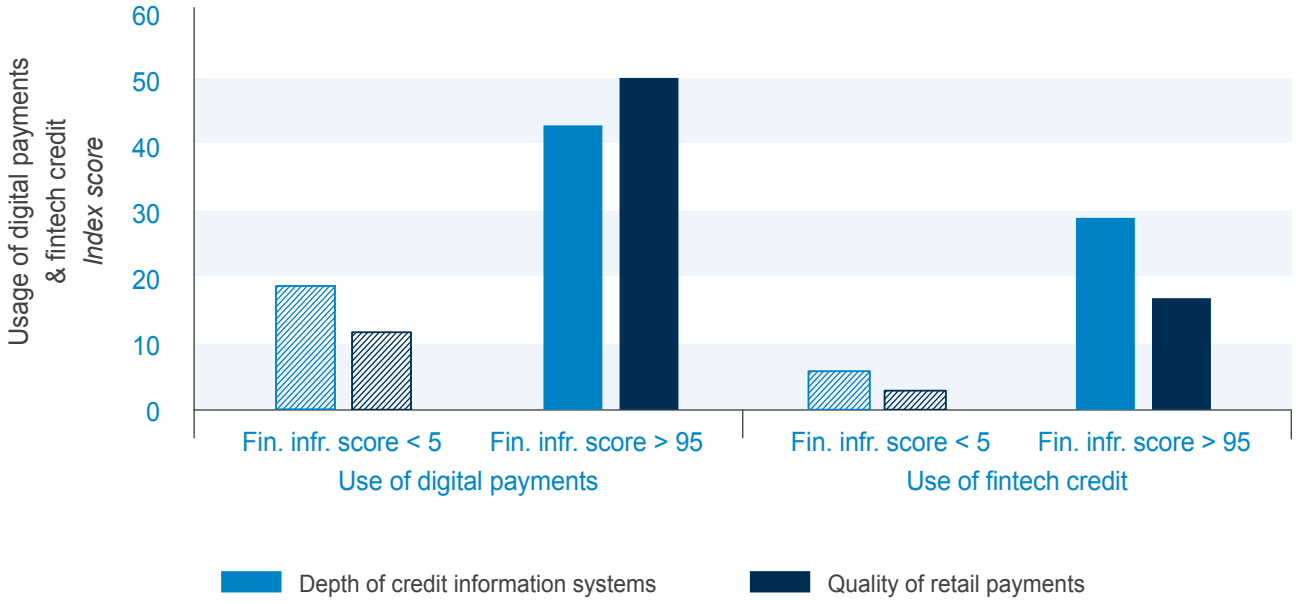
	Non-bank app downloads						Bank app downloads					
	1	2	3	4	5	6	7	8	9	10	11	12
Ln (GDP per capita)	0.573*	0.018	-0.050	0.629**	0.075	0.008	-0.025	-0.059	-0.092	-0.117	-0.124	-0.161
	[0.299]	[0.313]	[0.351]	[0.307]	[0.320]	[0.358]	[0.307]	[0.449]	[0.456]	[0.339]	[0.471]	[0.477]
Share young population	0.142**	0.182**	0.169**	0.121	0.157**	0.145*	0.269***	0.272***	0.265***	0.308***	0.309***	0.302***
	[0.069]	[0.071]	[0.076]	[0.076]	[0.076]	[0.080]	[0.077]	[0.075]	[0.076]	[0.093]	[0.089]	[0.091]
Share urban population	0.005	0.001	0.001	0.005	0.001	0.002	0.051***	0.051***	0.051***	0.050***	0.050***	0.050***
	[0.012]	[0.010]	[0.010]	[0.012]	[0.011]	[0.010]	[0.012]	[0.012]	[0.011]	[0.012]	[0.012]	[0.011]
Total app. downloads				0.001	0.002	0.002				-0.002	-0.002	-0.002
				[0.002]	[0.002]	[0.002]				[0.002]	[0.002]	[0.002]
Agg. infrastructure index	0.003			0.000			0.017			0.022		
	[0.016]			[0.016]			[0.019]			[0.019]		
ICT infrastructure		0.071***	0.078***		0.071***	0.078***		0.013	0.017		0.012	0.016
		[0.027]	[0.027]		[0.027]	[0.027]		[0.035]	[0.036]		[0.036]	[0.038]
Financial infrastructure		-0.004	-0.001		-0.006	-0.003		0.008	0.010		0.011	0.013
		[0.008]	[0.009]		[0.008]	[0.009]		[0.009]	[0.012]		[0.009]	[0.011]
Banking system development	0.003	-0.009	-0.017	-0.000	-0.013	-0.021	0.051***	0.050**	0.044**	0.056***	0.056**	0.050**
	[0.020]	[0.018]	[0.021]	[0.020]	[0.019]	[0.022]	[0.019]	[0.020]	[0.021]	[0.022]	[0.023]	[0.024]
Capital market development	0.019*	0.021**	0.024**	0.018*	0.020**	0.023**	-0.009	-0.009	-0.007	-0.007	-0.007	-0.005
	[0.010]	[0.009]	[0.010]	[0.010]	[0.009]	[0.010]	[0.010]	[0.010]	[0.010]	[0.010]	[0.010]	[0.010]
Agg. regulatory index	0.012	0.014*		0.009	0.010		0.022**	0.022**		0.027**	0.027**	
	[0.009]	[0.008]		[0.010]	[0.010]		[0.010]	[0.010]		[0.012]	[0.012]	
E-money laws			0.007			0.006			0.008			0.010
			[0.005]			[0.005]			[0.006]			[0.007]
Consumer protection index			-0.006			-0.007			0.001			0.002
			[0.011]			[0.011]			[0.011]			[0.012]
E-KYC			0.008			0.007			0.010**			0.012**
			[0.006]			[0.007]			[0.005]			[0.006]
Observations	47	47	47	47	47	47	47	47	47	47	47	47
(Pseudo) R-squared	0.122	0.134	0.136	0.123	0.135	0.138	0.167	0.167	0.168	0.170	0.170	0.171

Source: World Bank staff.
This table shows the cross-sectional regression analysis of the index representing financial app downloads on the potential drivers of fintech activity. The left panel shows the regressions for the index of non-bank financial app downloads, whereas the right panel shows the regressions for the index of commercial bank app downloads. Both indexes are constructed based on the number of app downloads as a share of the population. Robust standard errors are reported in brackets. *, **, and *** represent statistical significance at 10 percent, 5 percent, and 1 percent, respectively.

6.1 Fintech Activity and Infrastructure

Our estimations provide evidence that fintech activity is positively correlated with infrastructure. Greater access, usage, efficiency, and affordability of ICT infrastructure is associated with greater usage of digital payment services, larger volumes of fintech credit, and more investments in fintech companies. Regarding the financial infrastructure, our results indicate that its relationship with fintech activity depends on the type of fintech service provided. We find that financial infrastructure plays a particularly important role in the usage of digital payment services, with agent networks and the quality of retail payment system both being statistically significant. In contrast, credit information systems are particularly relevant for borrowing and lending fintech services (figure 11).

Figure 11. Fintech Activity and Financial Infrastructure



Source: World Bank staff.
This figure shows the average index scores for the usage of digital payments and usage of fintech credit, conditional on countries' scores on the financial infrastructure index.

6.2 Fintech Activity and Financial Development

Regarding the development and structure of financial systems, our regression results show a robust negative association between fintech activity and banking system development, once we control for the other enabling factors discussed above. The estimates are statistically significant for the aggregate fintech activity index as well as for its four pillars, and especially so for the index on equity investments in fintech firms.

Our results shed light on the competition channel, which reflects the extent of barriers to entry for new fintech players, and the inclusiveness channel discussed above, which reflects the potential demand for new financial service providers. On the latter, the results support the notion that entrepreneurial financial ventures would have more opportunities to

succeed in countries where there are more gaps in financial services provision by banks, including access as well as efficiency gaps. To the extent that fintech companies tend to target unbanked segments, we would expect greater fintech activity in countries with shallower and less inclusive banking systems.[63] Another possible explanation for our results relates to competition in the financial sector and the overall efficiency of financial service delivery, including the costs of credit provision. In countries with less competitive banking systems, the cost of financial services for customers tends to be higher, thus creating more space for the adoption of more efficient and less costly DFS, including those provided by fintech companies. Hence, we would observe greater opportunities for the adoption of DFS as well as the entry of fintech companies in countries with less competitive banking system typically characterized by less efficient and more costly provision of financial services. Moreover, there are arguably less incentives for incumbent banks to invest in fintech in a less competitive banking environment. That is, incumbents are more likely to adopt DFS in dynamic and competitive banking systems.

In contrast to the negative association with banking system development, we find that fintech activity is positively associated with capital market development. The results are particularly robust for investment in fintech companies, highlighting the role of venture capital, private equity, and capital markets in the funding of such companies (table 3a).

The estimation results on the number of finance app downloads show a more nuanced story regarding the role of financial system development, indicating that the distinction between incumbent banks and fintech companies is important (table 3d). Overall, the results seem to suggest that countries with deeper, more inclusive, and more competitive banking systems have weaker usage of digital financial services through mobile apps, although the results are not statistically significant. However, this negative correlation stems from the downloads of finance apps from institutions other than banks, such as fintech companies. Downloads of banking apps are in fact strongly positively associated with bank development (table 4). That is, bank app downloads tend to be greater in countries with deeper and more efficient banking systems, whereas the same is not observed for non-bank app downloads. These estimations provide support to the competition argument made above. From the supply side, a given demand for innovative digital financial services is more likely to be fulfilled by the incumbent providers when they are well-developed and there are smaller gaps in financial service provision. This can take place especially when these incumbent institutions are strong enough to hinder entry of new providers. From the demand side: there could be less overall demand for innovative financial services from new providers when incumbent institutions are well-developed. Customers may prefer to rely on such incumbent institutions for digital financial services as they have already stablished relationships, with some degree of trust.

Moreover, our estimations show a robust positive association between capital market development and non-bank finance app downloads, but not with bank app downloads. New financial service providers, such as fintech companies, arguably need more external funding to develop than incumbent financial institutions. Thus, an underdevelopment of equity and bond markets could hinder fintech activity. Indeed, many fintech companies cite funding constraints as a barrier to scale-up operations (Sahay et al. 2020). In contrast, the development of equity and bond markets has the opposite association with bank app downloads, being negatively related to it, though the results are not statistically significant.

Interestingly, the regression estimates also suggest notably different demographic patterns for bank app downloads in comparison to non-bank app downloads (table 4). While demographics in general does not seem strongly associated with fintech activity, we find clear patterns for bank app downloads. Our results show that bank app downloads tend to be larger in countries with a greater share of young adults (those between 20 and 39 years old) in their population and a larger urban population. The estimated coefficients are small and not statistically significant for non-bank app downloads. These estimations suggest that DFS offered by commercial banks have focused on certain segments of their existing client base, especially the more tech-savvy ones. The lack of such clear patterns for non-bank apps is consistent with financial services provided through fintech companies having greater variation in their customer base, with some reaching out to less-well served segments.

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63. Appendix table 7 reports the estimations expanding the banking system development index into its three components: access, depth, and efficiency.

6.3 Fintech Activity and the Enabling Policy Environment

The results for the policy environment suggest that the legal and regulatory environment is a necessary but not sufficient condition for fintech development. Countries that have high degree of fintech activity also score high in the aggregate regulatory index, but not all countries with a high-quality policy environment have high levels of fintech development (figure 10). Indeed, there are several countries that, despite having a well-developed regulatory framework, exhibit relatively low levels of fintech activity.

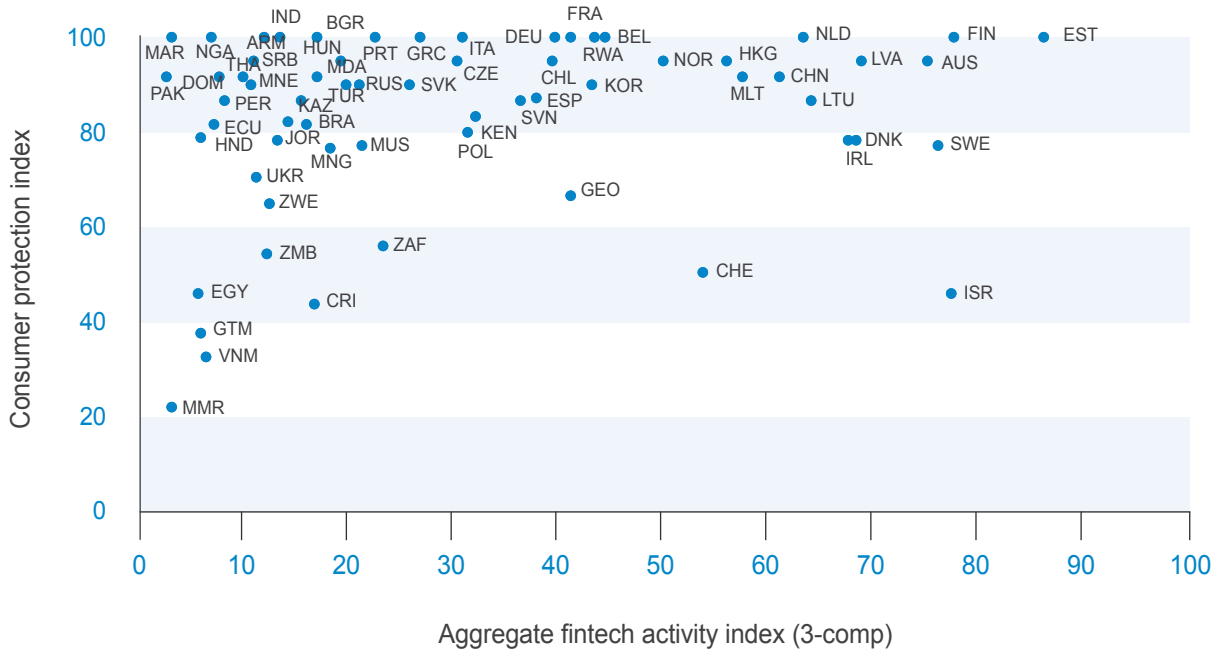
Regarding how sector-specific rules might enable or inhibit fintech development, the results show some mixed patterns. The coefficient for the indicator on e-money legal measures shows a weak positive association with usage of fintech credit, suggesting that entrepreneurial activity building on digital technologies for financial services would be more vigorous when laws and regulations are in place regarding one of its backbone instruments, e-money (table 3b). There is also a positive association with usage of digital payments, supporting the idea that when such regulations are in place, consumers gain confidence in digital financial services, thus increasing their usage of fintech credit and digital payment services (table 3c). However, when we include additional controls related to the legal and regulatory framework relevant for payment systems—including indicators capturing disclosure requirements, dispute resolutions, oversight, and simplified customer due diligence (CDD)—this correlation is no longer statistically significant. In fact, the regression results for the usage of digital payments show that there is no statistically significant relation between the usage of digital payments and these additional indicators on the legal and regulatory frameworks. However, it is important to bear in mind that policies such as simplified CDD facilitate transaction account opening. The results on the existence of a regulatory sandbox are also not statistically significant.

While the existence of laws and regulations for e-money, digital ID, and e-signatures (e-KYC frameworks) tends to be positively associated with fintech activity, the coefficient on consumer protection tends to be negative across most of our regressions (figure 12). A possible interpretation for this negative coefficient works through the supply side of fintech activity.[64] By imposing minimum standard requirements, restrictions in the provision of certain services, and greater legal responsibilities on financial service providers, consumer protection rules might discourage the entry of new fintech providers and the supply of fintech services and products more broadly. Supporting this interpretation, we indeed obtain statistically significant negative coefficients for the estimations on investments in fintech companies (table 3a).

While the analysis in this paper explores indicators capturing best practices for legal and regulatory frameworks to enable fintech activity, in the absence of relevant foundations, countries have likely resorted to alternative approaches in practice. For example, in the absence of a digital ID infrastructure, countries may have adopted tiered and simplified KYC requirements, accepting alternative forms of identity documentation such as a letter from the village elder as alternatives. Moreover, alternative combinations of policy choices can be adopted to open the markets for competition and foster fintech activity, with arguably similar results. Such combinations and qualitative improvements therein may not necessarily be fully captured in quantifying these reforms via multidimensional indices explored in this paper. Lastly, the relatively short time span of the data analyzed in this paper does not allow us to disentangle the relation of the enabling policy environment and fintech activity at different time horizons, which could lead to confounding effects. This could be the case for example if the enabling policy environment have a positive and stabilizing impact on fintech activity in the long term but a negative one in the short term.

64. In contrast, from the demand side, stronger consumer protection might boost fintech activity by increasing users' trust on digital financial providers. This trade-off between demand and supply effects is hinted at in the estimation results for finance app downloads (table 4). The coefficient on the consumer protection sub-index is positive (though not significant) for bank app downloads, suggesting that this demand-side channel may be at work. As commercial banks are likely to already comply with the consumer protection framework, it does not impose a greater regulatory burden. The negative coefficient for non-bank app downloads (also not significant) suggest that the first effect (the hindering of entrepreneurship/supply effect) tend to dominate the second (the trust effect) for such measure of fintech activity.

Figure 12. Fintech Activity and the Consumer Protection Framework



Source: World Bank staff.
This figure shows the relation between the aggregate fintech activity index (with 3 sub-components) and the consumer protection index.

7. Summary and Conclusions

Fintech will likely continue to shape the financial sector in terms of products, business models, and industrial organization, particularly in emerging market and developing economies where it has the largest potential to contribute to financial development, innovation, competition, and inclusion. In fact, the COVID-19 pandemic appears to have accelerated fintech adoption as a result of containment measures (such as lockdowns) and a fall in community mobility as evidenced by our analysis of finance mobile app download trends (appendix 3). We also establish that digital service providers can lower the costs of cross-border remittances, a key financial service for households in many EMDEs (appendix 5).

A small, but burgeoning literature aims to measure fintech activity and better understand its drivers, often with a specific product lens. This paper contributes to the literature by framing and quantifying fintech activity in a more comprehensive manner. Specifically, we take stock of a wide range of different types of fintech-related data and create an aggregate fintech activity index that captures three important dimensions (see appendix 1 for details): fintech firm creation and growth through the availability of early-stage financing; usage of fintech credit and digital payments, currently the most common digital financial services, especially in EMDEs; and the usage of mobile distribution channels for financial services, a key channel given that mobile and smart phones represent an increasingly important vehicle through which people live their digital lives. Nascent, but rapidly evolving digital financial services such as crypto-assets, stablecoins, central bank digital currencies, and decentralized finance (DeFi) are beyond the scope of the current version of our index.

It is important to highlight that the measurement of fintech activity is complicated by both the lack of a widely accepted definition as well as important data limitations (for example, gaps, lags, and cross-country comparability; see appendix 2 for considerations related to our data). As a result, the focus is on the cross-section, which inhibits causal inference. Another important limitation of our fintech activity index is that is does not capture the risks associated with fintech, which encompass financial stability, integrity, and consumer protection issues. These limitations are mostly attributable to the fact that most fintech activity is nascent and continues to advance rapidly from a low base in many countries, although big tech companies already play an important role in several economies, including by offering a wide range of financial services embedded in their platforms and by altering market structure and competitive dynamics through their large troves of data combined with strong network effects and economies of scale and scope (Market Structure note).

In this context, we show that our novel fintech activity index (as well as each of its three dimensions) is robustly correlated with a country's overall level of economic and institutional development. However, we find that significant variation across both regions and income groups persists. Most notably, the usage of fintech credit and digital payments has reached prominence in several low- and middle-income countries, particularly in EAP, ECA, and SSA.

Our findings suggest that enabling factors can account at least in part for differences in fintech activity across countries. A contribution of this paper is a comprehensive regression analysis of the association between fintech enablers and our indices of fintech activity. We collect a diverse set of data to construct indices that capture enabling factors related to: basic foundations such as ICT and financial infrastructures; financial sector development; and the fintech-relevant policy environment.

We find a strong correlation between ICT infrastructures and our fintech activity index and a lower cost of cross-border remittances. We also document that product-specific financial infrastructures also play a role (for example, credit information for fintech lending). We further find that fintech activity is typically more subdued in countries with more developed banking systems, potentially because there are fewer opportunities for new fintech entrants to emerge. However, financial incumbents may still have incentives to compete and adopt fintech. Indeed, we find that mobile banking app downloads are higher in countries with more developed banking sectors. Importantly, fintech activity (including non-bank mobile app downloads) is positively associated with deeper capital markets, possibly because this promotes a favorable start-up environment which is critical for fintech entrants.

Finally, our results suggest that fintech-specific policies are a necessary, but not sufficient condition to bring fintech activity about--other factors need to be in place as well for fintech activity to flourish. This finding may reflect the complexity of interactions between specific enablers and the broader policy and financial market environment – and this changes at different levels of fintech development as the digital ecosystem matures. It may also reflect that enabling policies such as simplified CDD can promote access through transaction account opening, but does not necessarily translate into significantly higher overall usage. Finally, regulation could have positive and stabilizing impact on fintech activity in the longer term. These benefits are not likely to be reflected in the analysis given the relatively short time horizon.

A few considerations and implications emerge. First, it is important to recognize that alternative policy combinations can promote innovation and foster fintech activity, with similar outcomes. For example, in the absence of a digital ID infrastructure (and supporting regulation), countries may adopt tiered and simplified KYC requirements to promote transaction account opening, which could accept alternative forms of identity documentation such as a letter from the village elder.

Second, consistent with existing literature, we find that the broader traditional policy environment matters. In appendix 4, we document that an operational environment with more stringent banking regulations appear to be less conducive to fintech activity. This may lead a general environment that is less permissive to innovation and new entrants while perhaps also offering fewer regulatory arbitrage opportunities for fintech entrants.

Third, the demands on the enabling environment evolve as fintech activity develops. For example, for basic e-money services to take off, fewer enablers are required than for more sophisticated digital financial services that not only presuppose the smooth functioning of digital transactions, but also require more complex, well-calibrated policy frameworks and financial infrastructures. Fintech activity may also outgrow basic consumer protection provisions as more complex consumer data protection frameworks become more important. Long-term, strategic government commitments to digitize government-to-person transactions and providing digital access to key government services can also act as a critical catalyst at various stages of fintech development (Pazarbasioglu 2020).

Fourth, finding the right balance between trade-offs at every stage of fintech development remains essential to promote activity and innovation while keeping excessive risks in check. For example, even if e-money rules or regulatory sandboxes exist, they could still exclude certain responsible actors from entering the financial services and accessing financial infrastructures. Similarly, while digital consumer protection measures are key to develop consumer trust (as we indicated by the analysis of cross-border remittances in appendix 5), they may also increase legal risks and compliance costs that preclude responsible risk taking and innovation. Taken together, these policy interactions, pre-conditions, and trade-offs at different stages of fintech development are inherently difficult to capture with the data at our current disposal – we therefore leave deeper analysis of the role of the enabling environment for fintech development for future research.

In light of the data limitations discussed above and the current stage of global fintech development, our fintech activity index will likely require revisions moving forward as fintech companies graduate from early-stage financing and become a significant part of the financial sector; the penetration of a broader range of digital financial services increases (for example, insurance, robo-advising, crypto-assets, stablecoins, central bank digital currencies, Decentralized Finance); enabling technology frameworks are further developed and adopted (for example, digital ID frameworks, open banking, and Application Programming Interfaces (APIs)); and regulatory perimeters and data collection efforts evolve and produce more granular (panel) data which would facilitate a richer analysis. We leave the challenges of capturing these developments for future research.

Appendix 1: Structure of Fintech Activity and Enablers Indices

Fintech Activity Index

Supply of Financial Services Through Fintech Firm Creation and Growth

1. Equity investments in fintech companies (Pitchbook and Crunchbase)

- Value of VC and PE investments in fintech firms, accumulated over the period 2014-18 (% of GDP in 2018)
- Number of fintech companies that received PE and VC equity investments during 2014-18 (per capita in 2018)
- Stock of fintech companies as of December 2018 (per capita)

Digital Forms of Common Financial Services

2. Usage of fintech credit (CCAF)

- Total new financing, accumulated over the period 2014-17 (% of GDP in 2018)

3. Usage of digital payment services by households and firms

3.1. Households (Global Findex Database, 2017)

- Share of the adult population that used the internet or mobile phone to access a financial institution account
- Share of the adult population that used the internet or mobile phone to check their account balance
- Share of the adult population that made or received digital payments in the past year through mobile phones or the internet
- Share of the adult population that used the internet to pay bills
- Share of the adult population that used a mobile phone to pay utility bills

3.2. Firms (Merchants Payments Database, 2015)

- Share of retail sales transactions by MSMRs that are paid electronically (P2B);
- Share of (immediate) supplier payments by MSMRs that are paid electronically;
- Share of wages by MSMRs that are paid electronically (B2P).

Mobile distribution channels

4. Downloads of finance mobile apps (Sensor Tower)

- The total number of finance app downloads, accumulated over 2014-18 (per capita in 2018)
- The total number of finance app downloads as a share of total 2014-18 app downloads

Potential Enablers of Fintech Activity

Basic Foundations

1. Economic development and demographics (WDI, 2018)

- GDP per capita (US$ Dollars)
- Share of the population between 20 and 39 years old
- Share of the population in urban areas

2. ICT infrastructure (ITU and GSMA, 2018)

2.1. Availability

- People with access to electricity, as a percentage of population (from WDI)
- Secure internet servers, measured per 1,000,000 inhabitants (from WDI)
- Mobile network coverage (any network type), as a percentage of population
- Mobile network coverage (at least 4G networks), as a percentage of population
- Availability of latest technologies index (ranges from 1 to 7) (from the World Economic Forum)

2.2. Usage

- Mobile-cellular subscriptions, measured per 100 inhabitants
- Fixed broadband subscriptions, measured per 100 inhabitants
- Mobile internet subscribers, as a percentage of population
- Mobile phone ownership and internet access, as a percentage of population (from Gallup, 2017)

2.3. Affordability

- Cost of 500mb data, as a percentage of GDP per capita
- Cost of fixed-broadband internet, as a percentage of GDP per capita
- Cost of cheapest internet-enabled mobile device, as a percentage of GDP per capita
- Herfindahl index of connections across mobile network providers, raging from 0 (evenly distributed competition) to 10,000 (no competition)

2.4. Efficiency

- International internet bandwidth per internet user (bit/s)
- Average mobile broadband download speed index (ranging from 0 to 100)
- Average mobile broadband upload speed index (ranging from 0 to 100)

3. Financial Infrastructure

3.1. Payment Systems (GPSS, 2017-2019)

- Interoperability of ATMs
- Interoperability of points of sales (POS)
- Interoperability of mobile money
- PAFI composite index on the quality of retail payment systems, reflecting the following systems: ACH, card switch, RTGS system, and instant/fast payments' system
- Whether regulations allow agent-based models for financial services provision

3.2. Credit Information Systems (Doing Business, 2018)

- Depth of credit information index
- Credit registry coverage, as a percentage of adult population

Financial Sector Development

1. Banking sector (FAS, Finstats, and Global Financial Development Database, 2018)

1.1. Access

- Number of commercial bank branches, measured per 100,000 adults
- Number of ATMs, measured per 100,000 adults
- Share of adults with an account at a formal financial institution

1.2. Depth

- Private credit by deposit money banks, as a percentage of GDP
- Financial system deposits, as a percentage of GDP

1.3. Efficiency

- Net interest margin defined as the ratio of net interest income divided by earning assets
- Bank overhead costs, measured as a share of total assets
- Assets of the three largest commercial banks as a share of total commercial banking assets (bank concentration)

2. Capital markets

2.1. Bond and Public Equity Markets (Refinitiv SDC Platinum)

- Domestic capital-raising equity issuance volume, accumulated over 2012-16, measured as a percentage of 2018 GDP
- Domestic corporate bond issuance volume, accumulated over 2012-16, measured as a percentage of 2018 GDP

2.2. Private Equity Markets (Pitchbook)

- Value of venture capital and private equity investments (excluding investments in fintech companies), accumulated over 2014-18, and measured as a percentage of 2018 GDP

Enabling policy environment

1. Legal and regulatory framework (GPSS and FICP surveys, 2017-2019)

1.1. E-KYC Frameworks

- Whether there are e-signature laws or regulations
- Whether there are digital ID laws or regulations
- Legal recognition of electronic processing of payments ("can electronic signatures/documents be used as evidence in the court of law?")

1.2. E-money Issuance

- Whether legal provisions cover e-money

1.3. Consumer Protection (*Alternative Consumer Protection)

- Whether there is a general consumer protection law*
- Whether there is a financial consumer protection law*
- Whether there are data privacy laws*
- PAFI composite index reflecting the existence of formal and external dispute resolution mechanisms
- PAFI composite index combining the existence of a variety of disclosure requirements: plain language (for example, understandable, prohibition of hidden clauses), local language, and prescribed standardized disclosure format, among others
- Whether there is deposit insurance

1.4. Payment Systems Regulatory Index

- PAFI composite index reflecting the existence of formal and external dispute resolution mechanisms
- PAFI composite index combining the existence of a variety of disclosure requirements: plain language (for example, understandable, prohibition of hidden clauses), local language, and prescribed standardized disclosure format, among others
- Whether there is deposit insurance
- PAFI oversight (risk management) composite index covering the following indicators: central bank legal powers, organizational arrangements, objectives of oversight, and cooperation with other authorities and stakeholders, and the scope of oversight.
- PAFI simplified due diligence composite index, which captures the following indicators for different financial service providers: acceptance of non-standard ID documents, non-face-to-face customer due diligence, and allowance for simplified transaction monitoring.

1.5. Regulatory Sandboxes (World Bank, 2020)

- Whether there was a regulatory sandbox for digital financial services in operation in December 2018

Appendix 2: Data Gaps and Limitations

The measure of fintech activity developed in this paper yields a comprehensive picture of the size of fintech services across countries. However, its underlying data present several limitations that are worth acknowledging. These data limitations are organized around the four pillars integrating the aggregate fintech activity index: (i) equity investments in fintech companies; (ii) usage of fintech credit; (iii) usage of digital payment services; and (iv) downloads of finance mobile applications.

First, the equity investments component only considers fintech firms that received venture capital and private equity financing during the period 2014-18, missing those fintech firms that obtained financing from other sources (for example, banks and/or family and friends). The index also misses companies providing fintech services that did not receive any equity investments. Moreover, by focusing on private equity finance, this index better captures the emergence of fintech companies in countries with relatively more developed VC and PE industries. In many countries, these industries are underdeveloped and, in those cases, fintech companies will likely rely on other sources of financing, including debt. That is, this indicator does not fully encompass all the aspects of financing the development of digital financial services. For instance, it does not capture the challenges that fintech lenders have in funding their loan books, nor does it capture fintech activity by incumbents who may be digitalizing payments or lending services without recourse to private equity funding. In addition, this index classifies companies based solely on the location of their headquarters, which can differ from where their operations take place. Particularly relevant in this case are companies whose headquarters are located in offshore centers. It is well documented in the literature that offshore centers can play an important role as intermediaries in international investments.

Second, the data on usage of fintech credit do not cover all of the online platforms providing digital financial services in the countries surveyed.[65] Specifically, the platforms covered by the CCAF survey are restricted to online, peer-to-peer, crowd-led marketplaces that are open at least partially to individual retail investors. For instance, the survey does not cover private crowdfunding platforms that are only open to corporate employees, credit provided on mobile and online payment platforms (such as Venmo in the United States, mPesa in Kenya, or AliPay in China), traditional financing not on open platforms (such as invoice factoring), or online loans held by the intermediary without being open to investment by outsiders. Moreover, in some countries, only the largest platforms are included in the dataset. The survey data also excludes some types of activities that could arguably be considered as fintech credit. For example, online mortgage lenders are not covered, even when they automate nearly all processes and match borrowers with institutional investors. Similarly, large technology or big tech firms—most notably e-commerce platforms that extend credit to merchants using their platforms—are excluded from the data in many countries, despite having gained importance as lenders in recent years.[66]

Third, the Merchants Payments indicators included in the usage of digital payments index provide an estimate of the volume of digital payments for a certain segment, namely MSMRs. Payments by large corporations or government payments (payments to and payments by the government, local and central) are not included in these data. Moreover,

65. Claessens et al. (2018) provides a discussion of the modus operandi of these fintech platforms in comparison with those of traditional credit providers such as banks.
66. Cornelli et al. (2020) provides a recent analysis of big tech credit.

the indicators capture any type of electronic payment conducted by MSMRs, including non-digital transactions such as those made with debit and credit cards. Another caveat of these data is that primary data is obtained for a sample of seven countries, for which interviews and surveys were conducted with retailers, wholesalers, industry associations and/or government agencies. Simulations are then used to estimate the volume of electronic payments for MSMRs to a larger sample of 168 countries, extrapolating the data from these seven countries.[67]

Fourth, the app download data are estimates, not primary data. These estimates are calculated by Sensor Tower based on primary data on app download rankings and app metadata from Google and Apple app stores combined with data provided by individual publisher and developer sources. Hence, the accuracy of these download estimates depends on the coverage of these alternative publisher and developer sources. While the list of these sources is confidential, Sensor Tower discloses that their sources generated more than 50 percent of global app store revenues in 2018. Another caveat of these data is that not all countries have data from both Google and Apple app stores. Some countries have data only from one of these providers. The most notable case is China, for which the download data come solely from Apple app store.

67. In light of these caveats, we evaluated the robustness of our findings to the exclusion of this set of indicators. These results focusing only on the usage of digital payments index from the household perspective are qualitatively similar to the reported ones.

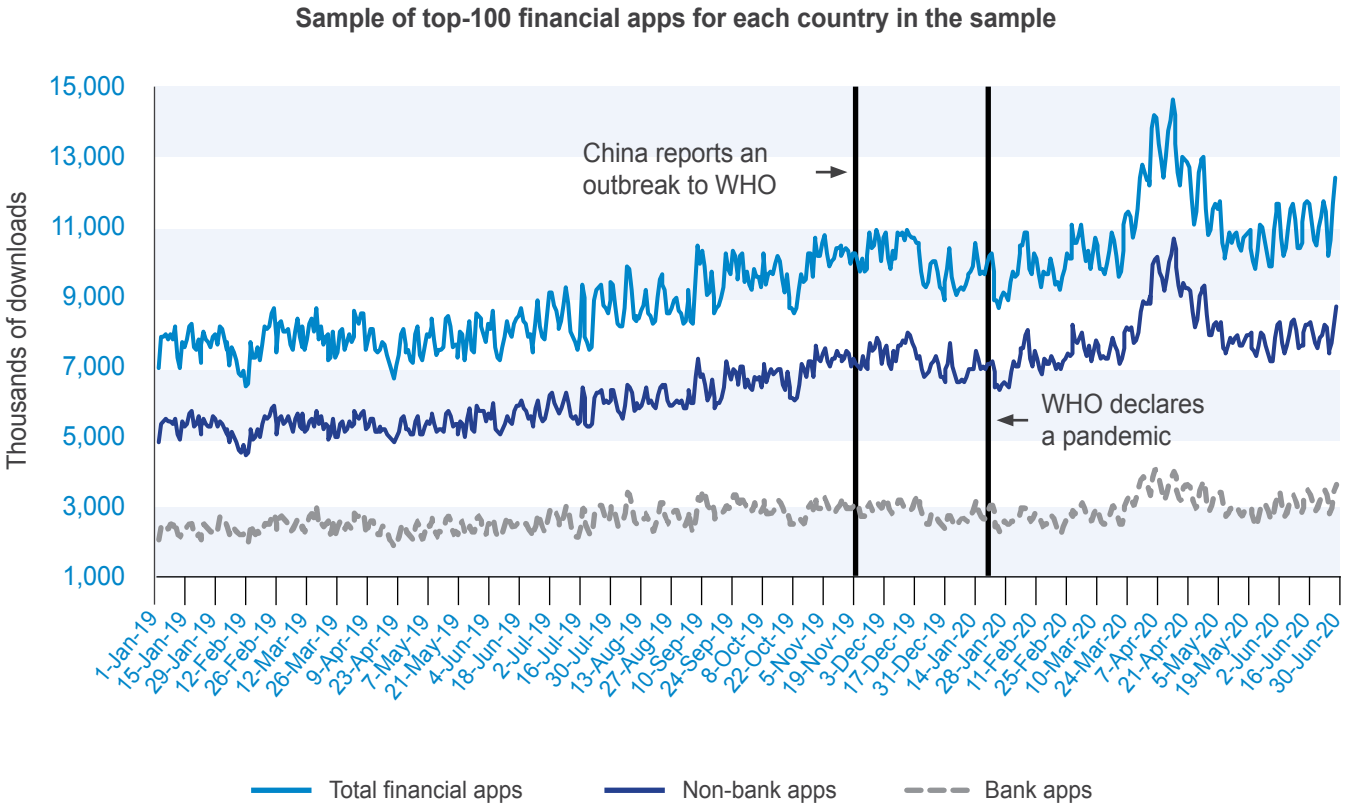
Appendix 3: Financial App Downloads During the COVID-19 Pandemic

The social distancing and other containment measures (for example, quarantines, travel restrictions) adopted on a global scale to mitigate the spread of the COVID-19 pandemic have stressed the benefits of DFS. While traditional financial services are predominantly built on cash transactions and face-to-face interactions with financial service providers, digital financial services enable remote, contactless, and cashless payments and transactions. DFS, especially through the use of mobile money, might thus facilitate social distancing. Moreover, they facilitate an effective, quick, and wide-reaching deployment of government support programs, including to those in the informal sector and those who do not have access to bank accounts (Goodwin-Groen 2020; IMF 2020a).

While many have speculated that the pandemic crisis has the potential to accelerate the adoption of DFS, the evidence to date has been limited (Agur et al. 2020; Arner et al. 2020; Auer et al. 2020b; Pazarbasioglu et al. 2020). The app download data, reflecting the stream of new users of financial apps, can provide some early insights into DFS adoption worldwide during the COVID-19 pandemic. For each country in the sample, we analyze the downloads of the top-100 financial apps in that particular country with available daily data over the October 2019–June 2020 period. In addition, to explore the role played by banks vis-à-vis other financial institutions (including fintech companies) during the crisis, we classify these top-100 financial apps into bank and non-bank apps. We do so by identifying in the financial app data those institutions that are classified as commercial banks in the Bureau van Dijk's Bankscope database for each country in the sample.

The data show that there has been a marked spike in worldwide financial app downloads during the peak months of the COVID-19 pandemic (figure B1.1). The increase is particularly marked for non-bank financial apps. Global downloads of non-bank financial apps increased 45 percent, from an average of about 7 million downloads per day during the last quarter of 2019 (2019Q4) to over 10 million at its peak on April 15, 2020 and around the peak of policy measures taken to constrain community mobility (Hale et al. 2020). Bank app downloads increased 36 percent on its peak day April 7th, 2020, up from about 2.8 million downloads per day on average during 2019Q4. The marked increase in financial app downloads, however, seems to have been relatively short lived. The average number of app downloads during the last week of June 2020 was only slightly above its pre-pandemic level, with a growth of about 10 percent relative to 2019Q4 for both bank and non-bank financial apps. However, caution is called for in interpreting these patterns as app downloads are a "flow" variable and do not directly measure usage, as discussed above. Such decline in downloads by June from the peak levels observed in mid-April does not mean that DFS usage fell, but rather that fewer people became new users of financial apps as the spread of COVID-19 subdued.

Figure B1.1. Worldwide Downloads of Financial Apps during the Pandemic



Source: World Bank staff.

While these aggregate trends mask large cross-country dispersion, there is a robust positive correlation at the country level between the growth in downloads of top-100 financial apps since the outbreak of the pandemic and the severity of the impact of COVID-19 (figure B1.2). For example, countries with a greater number of COVID-19 cases (measured in absolute terms or per capita) during peak months had, on average, larger increases in financial app downloads. Moreover, there is a robust association between financial app downloads and high-frequency proxies for the strength of social distancing practices. For instance, countries that adopted more stringent lockdown policies or countries with greater declines in actual community mobility during the peak of the pandemic experienced, on average, greater increases in financial app downloads. These patterns suggest that as people reduced their physical interactions during the height of the COVID-19 outbreak, they turned to DFS.

Using an OLS panel regression framework, we formally assess the robustness of these trends. Specifically, we estimate the following regression specification:

$$AppDownl_{i,t} = \alpha + \beta_1 Pandemic_{i,t} + \theta_i + \varepsilon_{i,t},$$

where the dependent variable $AppDownl$ is either: (i) the growth rate of the top-100 financial app downloads relative to 2019Q4, calculated as the ratio of the aggregate number of financial app downloads in a given day t in country i over the average number of daily downloads observed during 2019Q4; or (ii) the growth in the ratio of the number of non-bank app downloads to bank app downloads in a given day relative to the average ratio observed during 2019Q4. The key independent variable is the $Pandemic$, which is either one or a combination of the following proxies for the incidence of the pandemic in country i: (i) the number of newly confirmed COVID-19 cases per 100,000 people in a given day t; (ii) Oxford's Index of Stringency of Lockdown policies in a given day t; and (iii) changes in the Google's community mobility index in a given day t relative to the median value for that corresponding day of the week during the 5-week period of Jan 3–Feb 6, 2020. The regressions also include a set of time invariant country variables, measured through either country fixed effects or a set of country characteristics (GDP per capita, share of urban population, and share of young population). These regressions are estimated on daily data for the period March 2020 to June 2020.

The estimations show that the greater the impact of COVID-19 was in a given country, the greater the increase in financial app downloads (table B1.1, panel A). The results also suggest that such increase in financial app downloads was related to the stringency of community mobility policies or practices rather than the contagion of the disease itself in a given country. For instance, when we include more than one proxy for the incidence of the pandemic, the variables related to social distancing practices are statistically significant, but the number of new COVID-19 cases is not.

Furthermore, the increase in financial app downloads during the pandemic occurred especially in countries with larger urban populations and lower per capita incomes. This suggests that new users of financial apps were predominantly in urban centers, where the need for social distancing practices may have been stronger. The negative estimates on countries' income per capita might reflect, among other things, the extent of ex ante adoption of digital financial services. As discussed in the main text, more developed countries usually exhibit greater DFS adoption rates (proxied by our finance app download index) before the pandemic hit, thus reducing the scope for increases in the user base captured by the app downloads data.

The regressions indicate that non-bank app downloads have increased relatively more than bank apps during the pandemic, though the differences seem (at best) weakly correlated with the incidence of the pandemic (table B1.1, panel B). If both bank and non-bank app downloads have increased at the same rate during the pandemic, the ratio would have remained constant. However, the regressions show that the ratio increased during the first half of 2020. While the results provide some evidence that there are such level differences across different types of apps across countries, they also suggest that such differences do not vary consistently with the incidence of the pandemic.

Figure B1.2. Growth in Financial App. Downloads and the Incidence of the Pandemic

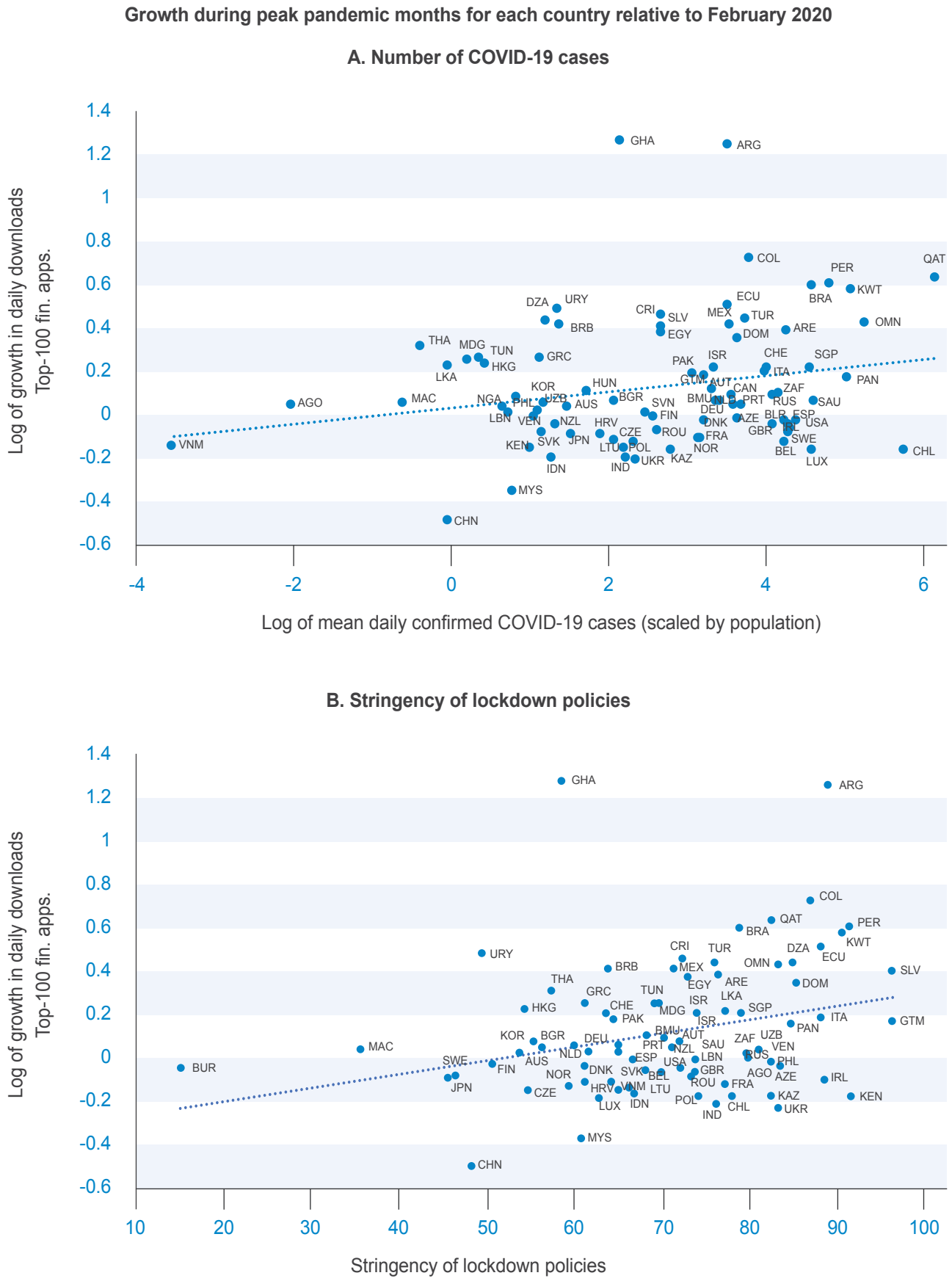
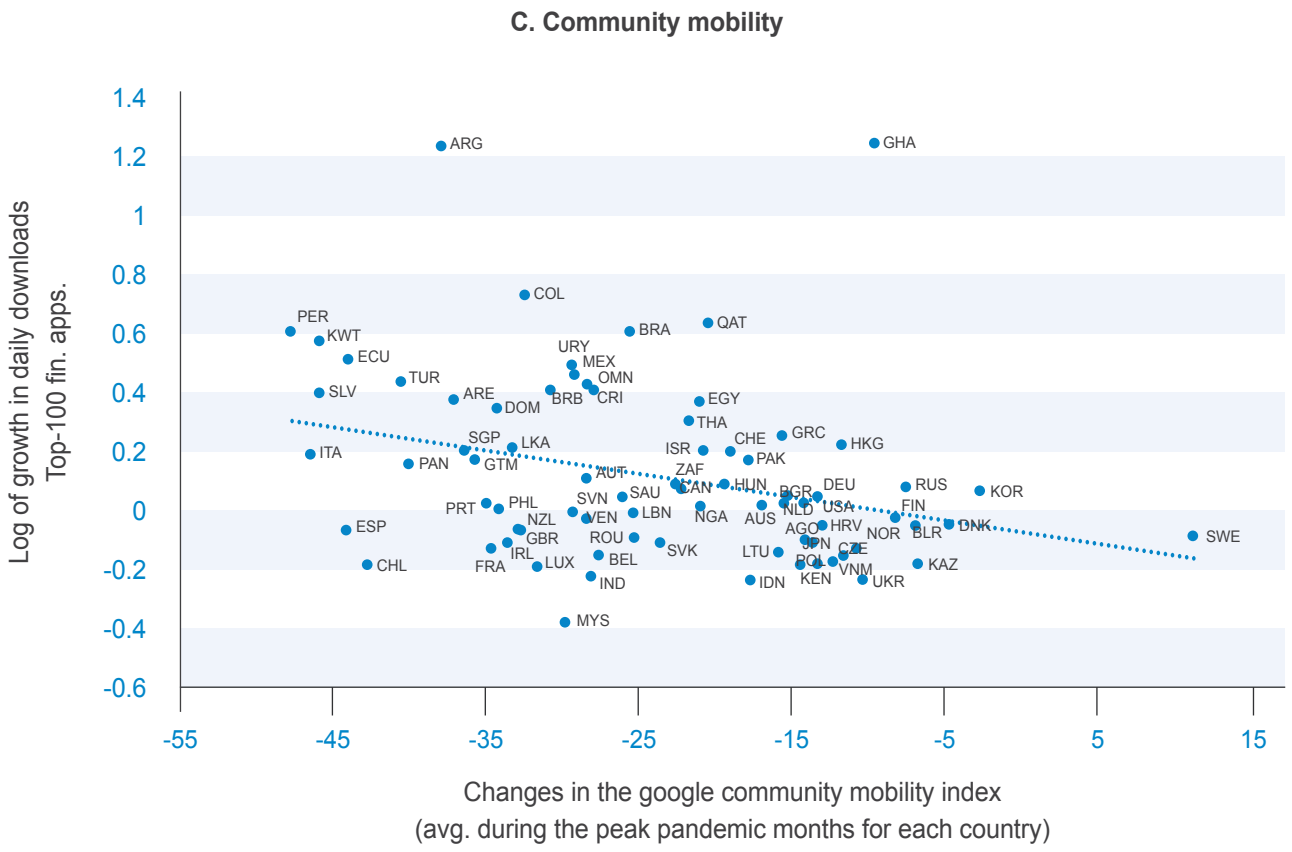


Figure B1.2 continued



Source: World Bank staff.
Notes: The growth in app downloads is measured as growth in the number of new app downloads in the peak months of the pandemic relative to the number of new app downloads in February 2020. For a given country, the peak pandemic months are defined as those months that have days in the top of the distribution of new cases in that country. As a threshold, we consider the 90th percentile of the distribution. For China and Macao SAR, China, both January and February 2020 are considered peak months, and so we calculate growth rates relative to December 2019. For Republic of Korea, February 2020 is a peak month, so we calculate growth rates relative to January 2020. The number of cases, the stringency of lockdown policies and changes in community mobility are measured during each country's peak pandemic months.

Table B1.1. Financial App Downloads during the COVID-19 Pandemic

A. Financial app. downloads								
Daily growth rates relative to 2019Q4								
	1	2	3	4	5	6	7	8
Ln (new cases per capita)	0.013**	0.028***					0.005	0.015
	[0.005]	[0.007]					[0.008]	[0.011]
Stringency of lockdown policies			0.002***	0.002***			-0.001	-0.002
			[0.001]	[0.001]			[0.001]	[0.001]
Community mobility index					-0.003***	-0.005***	-0.003***	-0.006***
					[0.001]	[0.001]	[0.001]	[0.002]
Ln (GDP per capita)		-0.132***		-0.101**		-0.067		-0.088**
		[0.041]		[0.042]		[0.042]		[0.043]
Share young population		0.005		0.006		0.004		0.004
		[0.006]		[0.006]		[0.006]		[0.006]
Share urban population		0.008***		0.007**		0.007**		0.007***
		[0.003]		[0.003]		[0.003]		[0.003]
Constant		-0.257		-0.436**		-0.383*		-0.257
		[0.212]		[0.213]		[0.221]		[0.240]
Observations	9,484	9,396	9,955	9,833	9,150	9,150	8,537	8,537
R-squared	0.015	0.191	0.034	0.155	0.061	0.197	0.041	0.229
Number of countries	83	83	83	83	75	75	75	75
Country fixed effects	Yes	No	Yes	No	Yes	No	Yes	No

Table B1.1 continued

B. Ratio of non-bank to bank app downloads								
Daily growth rates relative to 2019Q4								
	1	2	3	4	5	6	7	8
Ln (new cases per capita)	0.010	0.024**					0.010	0.025*
	[0.006]	[0.009]					[0.010]	[0.013]
Stringency of lockdown policies			0.001**	0.001**			-0.001	-0.000
			[0.001]	[0.001]			[0.001]	[0.001]
Community mobility index					-0.002**	-0.002	-0.001	-0.000
					[0.001]	[0.001]	[0.001]	[0.002]
Ln (GDP per capita)		-0.063*		-0.042		-0.019		-0.047
		[0.037]		[0.036]		[0.038]		[0.042]
Share young population		-0.013***		-0.013***		-0.012***		-0.013***
		[0.004]		[0.004]		[0.005]		[0.004]
Share urban population		0.003		0.003		0.002		0.002
		[0.003]		[0.003]		[0.002]		[0.003]
Constant		0.497***		0.387**		0.382**		0.494**
		[0.176]		[0.176]		[0.180]		[0.217]
Observations	9,484	9,396	9,955	9,833	9,150	9,150	8,537	8,537
R-squared	0.008	0.072	0.014	0.052	0.016	0.048	0.014	0.072
Number of countries	83	83	83	83	75	75	75	75
Country fixed effects	Yes	No	Yes	No	Yes	No	Yes	No

Source: World Bank staff.
This table reports panel regression estimates of the growth in financial app downloads (panel A) and the ratio of non-bank to bank app downloads (panel B) on the incidence of the COVID-19 pandemic. The dependent variable in panel A is the growth rate of the top-100 financial app downloads calculated as the ratio of the aggregate number of app downloads in a given country in a day over the average number of daily downloads observed during 2019Q4. In panel B, the dependent variable is the growth in the ratio of the number of non-bank app downloads to bank app downloads in a given day relative to the average ratio observed during 2019Q4. The main explanatory variables are proxies for incidence of the COVID-19 pandemic: the number of cases per capita, Oxford's Index measuring the stringency of the lockdown policies, and changes in the Google's community mobility index. Both the dependent and independent variables are measured as 7-day moving averages to smooth out large day-to-day volatility. Some of the specifications include country fixed effects, or alternatively, variables with country characteristics (GDP per capita, share of young population, and share of urban population). The estimations are based on daily data from January 1st, 2020 to June 30, 2020. Robust standard errors, shown in brackets, are clustered at the country level. *, **, and *** represent statistical significance at 10%, 5%, and 1%, respectively.

Appendix 4: Stringency of Banking Regulation and Fintech Activity

A few studies provide some evidence of a negative association between the stringency of banking regulation and fintech development, using similar data to those explored in this paper. For example, Navaretti et al. (2017) find, for a sample of 33 European countries, that those with less stringent banking regulation had higher investments in fintech companies, suggesting that these countries may also be more permissive towards new entrants. Similarly, Claessens et al. (2018) find that fintech credit volumes are higher in countries with less stringent banking regulation, consistent with fintech regulations being more liberal in countries where banking regulation is more liberal.

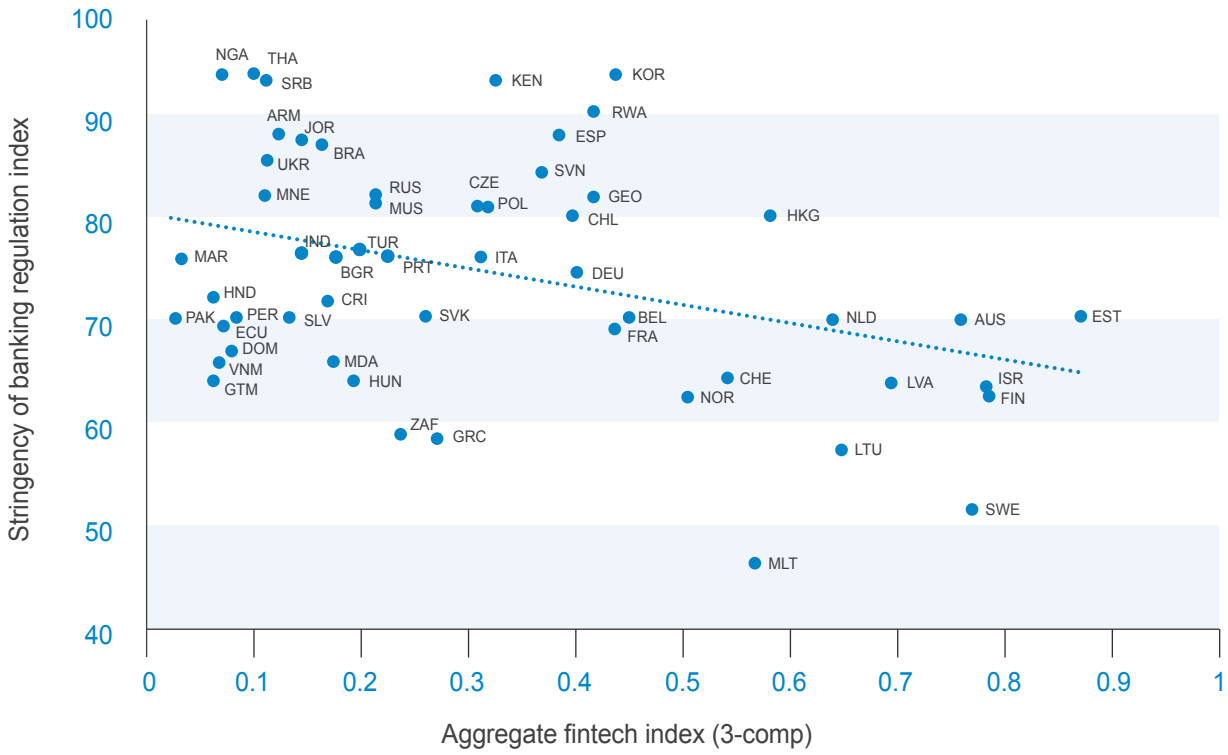
It is worth emphasizing that the stringency composite indicator captures only the regulatory landscape for banking regulation and supervision. It is possible that fintech-specific rules matter as well. For instance, less intense regulation of fintech activities could foster their development; it could even encourage regulatory arbitrage to the extent that similar risks are regulated more tightly in the traditional lending sector. The evidence from these studies would tend to dispel the idea that, from the supply side, fintech development is driven by regulatory arbitrage.

Following the above-mentioned studies, we construct a stringency of banking regulation index as in Mansilla-Fernández (2017), using 18 indicators from the World Bank's Bank Regulation and Supervision Survey to measure the sensitivity of the regulatory system to bank risk-taking. The index takes a value between 0 (least stringent) and 1 (most stringent).

Our results are consistent with those reported in previous research (figure B2.1 and table B2.1). The regression estimates show that the stringency of banking regulation is negatively associated with aggregate fintech activity. This negative association stem from a negative correlation with investments in fintech companies and with usage of fintech credit, though not statistically significant in the latter. These results are robust to the inclusion of all other indicators examined in this paper capturing potential enabling factors of fintech activity, including those on banking and capital market development. Importantly, adding banking regulatory stringency did not change previously discussed results. The overall development of banking systems (access, depth, and efficiency) tends to be negatively associated with fintech activity.

In contrast, the results for the finance app downloads show a positive association with the stringency of banking regulation, seemingly driven by bank app downloads, once again, highlighting the importance of distinguishing between bank and non-bank financial service providers. The results show a strong positive association between the stringency of banking regulation and bank financial app downloads, in addition to the positive association with banking sector development discussed above (table B2.2). These results suggest that more stringent regulation might engender some trust in these new forms of financial intermediation, fostering usage from existing users of financial services (as the shares of young adults and urban population remain strongly significant). The results on non-bank app downloads are also positive, but not statistically significant, possibly reflecting the trade-off between a positive trust effect and a negative entrepreneurship effect—it may be more difficult to launch new fintech activities in countries with relatively strict prudential and bank licensing regimes.

Figure B2.1. Fintech Activity and Stringency in Banking Regulation



Source: World Bank staff.
This figure plots the aggregate fintech activity index (with 3 sub-components) against an index capturing the stringency of banking regulation. The figure also shows a linear trendline.

Table B2.1. Stringency of Banking Regulation

	Investments in fintech		Fintech credit		Usage index	
Variables	**1**	**2**	**3**	**4**	**5**	**6**
Ln (GDP per capita)	0.909***	0.240	0.410	-0.046	1.485***	1.079***
	[0.333]	[0.377]	[0.596]	[0.617]	[0.192]	[0.238]
Share young population	0.053	0.059	-0.095	-0.112	0.031	0.042
	[0.072]	[0.066]	[0.119]	[0.109]	[0.044]	[0.039]
Share of urban pop.	-0.014	-0.016	-0.014	-0.016	-0.017*	-0.017**
	[0.018]	[0.016]	[0.019]	[0.019]	[0.009]	[0.008]
Stringency of banking regulation	-0.051**	-0.052***	-0.013	-0.019	0.003	0.006
	[0.020]	[0.018]	[0.023]	[0.030]	[0.009]	[0.010]
Banking system development	-0.009	-0.039	-0.076**	-0.117***	-0.039***	-0.050***
	[0.033]	[0.025]	[0.038]	[0.034]	[0.015]	[0.016]
Capital market development	0.029*	0.041***	0.025	0.041**	0.012*	0.016**
	[0.017]	[0.011]	[0.021]	[0.020]	[0.006]	[0.007]
Aggregate infrastructure index	-0.011		0.047		0.019*	
	[0.027]		[0.060]		[0.011]	
ICT infrastructure		0.072**		0.084		0.057***
		[0.036]		[0.052]		[0.017]
Financial Infrastructure		0.006		0.037*		0.008
		[0.011]		[0.020]		[0.006]
Aggregate regulatory index	0.012		0.020		0.011**	
	[0.010]		[0.016]		[0.005]	
E-money regulations		0.023***		0.032**		0.002
		[0.009]		[0.013]		[0.003]
Consumer protection		-0.034***		-0.055**		0.000
		[0.013]		[0.025]		[0.007]
E-KYC		0.010		0.023*		0.006
		[0.006]		[0.012]		[0.004]
Observations	54	54	54	54	55	55
R-squared	0.234	0.260	0.0961	0.166	0.219	0.225

Source: World Bank staff.
This table shows the cross-sectional regression analysis of the sub-components of the aggregate fintech acticity index (equity investments in fintech, fintech credit, and usage of digital payments) on the potential drivers of fintech activity. Robust standard errors are reported in brackets. *, **, and *** represent statistical significance at 10 percent, 5 percent, and 1 percent, respectively.

Table B2.2. Stringency of Banking Regulation for Finance App Downloads

	Finance app. downloads		Non-bank apps		Bank apps	
Variables	**1**	**2**	**3**	**4**	**5**	**6**
Ln (GDP per capita)	0.639**	0.319	0.839**	0.086	-0.069	-0.474
	[0.287]	[0.346]	[0.390]	[0.428]	[0.368]	[0.554]
Share young population	0.081	0.069	0.130**	0.124*	0.232***	0.235***
	[0.058]	[0.071]	[0.066]	[0.073]	[0.081]	[0.083]
Share urban population	0.001	0.002	-0.005	-0.004	0.058***	0.056***
	[0.011]	[0.010]	[0.013]	[0.011]	[0.012]	[0.012]
Stringency of banking regulation	0.036**	0.037**	0.024	0.032*	0.034*	0.041**
	[0.017]	[0.017]	[0.020]	[0.018]	[0.019]	[0.019]
Banking system development	-0.034	-0.049**	-0.020	-0.049**	0.045*	0.022
	[0.021]	[0.021]	[0.023]	[0.021]	[0.023]	[0.029]
Capital market development	0.029***	0.034***	0.029**	0.038***	-0.005	0.002
	[0.010]	[0.011]	[0.012]	[0.011]	[0.011]	[0.014]
Aggregate infrastructure index	0.008		0.013		0.019	
	[0.019]		[0.022]		[0.023]	
ICT infrastructure		0.039		0.092***		0.064*
		[0.024]		[0.025]		[0.038]
Financial infrastructure		0.010		0.007		0.010
		[0.011]		[0.012]		[0.016]
Aggregate regulatory index	0.003		0.004		0.012	
	[0.007]		[0.009]		[0.010]	
E-money regulations		0.008		0.008		0.007
		[0.005]		[0.006]		[0.007]
Consumer protection		-0.016		-0.022		-0.010
		[0.013]		[0.014]		[0.016]
E-KYC		0.002		0.006		0.008*
		[0.005]		[0.007]		[0.005]
Observations	42	42	42	42	42	42
R-squared	0.0894	0.0953	0.134	0.154	0.194	0.202

Source: World Bank staff.
This table shows the cross-sectional regression analysis of indexes capturing financial app downloads on the potential drivers of fintech activity. Robust standard errors are reported in brackets. *, **, and *** represent statistical significance at 10 percent, 5 percent, and 1 percent, respectively.

Appendix 5: The Cost of Remittances and the Role of Digital Financial Service Providers

Remittances are usually understood as cross-border transfers that migrant workers send to their families and friends back in their home country. Until recently, the remittances industry was estimated to officially move close to $700 billion around the world, with more than 75 percent of these flows sent to low- and middle-income countries.[68] For developing countries, remittance flows can constitute a significant source of external funding, and for many, they are as large as foreign direct investments and even exceed official aid flows by a significant margin. Importantly, several studies provide evidence that remittances are an important channel of poverty reduction (Lopez Cordova 2005; Ratha 2007; Woodruff and Zenteno 2007; Giuliano and Ruiz-Arranz 2009; Zhunio et al. 2012; Amega and Tajani 2018).

A fall in these cross-border transfers, such as the one currently estimated during the COVID-19 pandemic, could put many families at risk.[69] In the face of the COVID-19 pandemic, the financial resilience for millions of migrants and their families have been at risk. While reducing the cost of sending remittances has been on the agenda of the international community for a while and eventually became one of the UN SDGs,[70] it has now turned out to be even more relevant in the context of the COVID-19 crisis, as reduced costs can translate into more funds made available to the receiving families to improve their well-being.

The cost of sending remittances plays an important role for the incomes of migrants and their families. For sending $200, costs can vary from $1.96 to $40 on average across different corridors (i.e. specific country pairs).[71] An analysis of remittance cost data across 367 corridors worldwide, from 48 remittance sending countries to 105 receiving countries, shows that commercial banks were the most expensive channel for remittances, charging on average 10.6 percent of the amount sent in the first quarter of 2020 (table B3.1).[72] In contrast, non-bank channels (such as money transfer operators) charged on average 6 percent over the same period. Most of the differences in cost across providers seem to stem from their transaction fee charges. Differences in the foreign exchange margins across providers were relatively small at about 2 percent. There were also differences across providers regarding the speed at which funds are transferred: it took on average longer than two days to send $200 via banks, whereas it took about 17 hours to send the same amount through non-bank channels.

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68. The top-5 recipient countries for remittance flows as a share of GDP were Tonga, Haiti, Sudan, the Kyrgyz Republic, and Tajikistan. The top-5 recipients in absolute terms were India, China, Mexico, the Philippines, and the Arab Republic of Egypt.
69. The most recent estimates by the World Bank point to a 7.2 percent decline in remittance flows to low- and middle-income countries (LMICs) in 2020 followed by an additional 7.5 percent in 2021 (World Bank 2020. Migration and Development Brief, #33).
70. Reducing the cost of sending remittances has been on the agenda of the international community since the late-2000s when the 5x5 objectives were adopted by the G8 in the L'Aquila Summit and then by the G20, and later on by the UN SDGs (10.c.1).
71. Remittance Prices Worldwide (RPW) database, World Bank, Q1 2020. Please note that data from Q1 2020 was used as it is the last quarter before the spread of COVID-19.
72. Banks have traditionally remained away from the remittances market. Some have argued that banks view remittances as a marginal product and are thus less likely to offer competitive prices (Ratha and Riedberg 2005). Consistent with this view, Beck and Martinez Peria (2011) find a positive correlation between the share of bank service providers in a given corridor and the average cost of remittances.

Table B3.1. Sending $200 across Borders

	All providers	Banks	Non-banks
Average total cost	6.74%	10.55%	5.99%
Average transaction fee	4.52%	8.40%	3.75%
Average foreign exchange margin	2.22%	2.14%	2.23%
Speed of transaction (average no. of hours)	25.13	68.73	16.50

Source: World Bank staff.

Fintech innovations can play a major role in reducing remittances costs. Service providers can leverage new technologies to offer cheaper, more convenient, and faster services, which would benefit both senders and recipients (The Economist 2019). For instance, a World Bank (2018) study in Albania estimated that if half of the remittances received in cash were received via e-money instruments, migrants and their families could have saved up to $1.3 million annually, whereas service providers could have saved up to $6.7 million in costs. The digitalization of remittance services could also translate in reduced time and effort required to make these transfers. Xoom (2017) estimates that digital remittances could save remittance recipients in Mexico 15 days over the course of their lives.

The COVID-19 pandemic has emphasized the importance of digital instruments for sending and receiving remittances (Garcia Mora and Rutkowski 2020) as remittance service providers (RSPs) across the board had operational disruptions due to the imposed lockdowns. In some countries, RSP services had to stop until remittances were declared essential services; in some others, RSPs had restricted office hours; and in many others, social distancing rules meant the number of customers serviced in RSP locations had to be reduced significantly. All these resulted in unavailability of some services, especially the cash-based ones. Pulse surveys with regulators and RSPs showed an increase in the use of digital channels, and a consequent decline in the average cost of sending remittances for the surveyed corridors.[73]

We now turn to a regression analysis to examine the role of digital services in bringing down remittance costs charged by non-bank providers. We study the correlates of remittance costs across corridors, considering the different components of the average cost of sending $200 as different dependent variables.[74] Our main independent variable is the share of services offered by digital MTOs, measured at the corridor level.[75] Furthermore, the corridor level data allow us to conduct a bilateral analysis of costs, taking into account origin and destination specific characteristics (such GDP per capita, available infrastructure, regulatory framework). We also examine how remittance costs depend on distance between countries and a number of other corridor-specific variables (for example, speed of the transaction, number of remittance providers, the number of migrants, geographic distance between the two countries, whether the origin and destination countries have a shared border and a common official language). Our estimation results are reported in table B3.2.

73. For further information, please see RPW Special Issues available at http://remittanceprices.worldbank.org, and World Bank (2021).
74. We also look at different breakdowns of the dependent variable such as transaction fee vs. foreign exchange margin, average cost of sending via different channels, average cost of sending via different payment instruments, and average cost of sending for different disbursement methods. The full set of estimation results (and their interpretation) are not included in this appendix due to space limitations, but are available at Ardic and Natarajan (2021).
75. "Digital" MTOs are those non-bank innovative service providers that provide remittance services which are funded by non-cash payment instruments.

We find supporting evidence for a negative relationship between the availability of services offered by digital MTOs and the average cost of sending $200 at the corridor level and its component associated with transfer fees). That is, a larger share of services offered by digital MTOs is associated with lower average costs and lower transfer fees. The estimations also indicate that more developed infrastructure and enabling legal and regulatory frameworks for payments in the sender jurisdiction are associated with lower average cost of sending remittances as well as average fees. According to our analysis, the existence of restrictions on outward person-to-person (P2P) transfers imposed by the sending jurisdiction is linked to higher average cost and higher average fee of sending $200, potentially acting as a barrier. Lastly, floating exchange rate regime in the sending jurisdiction is found to be related to higher average foreign exchange margins, likely due to higher uncertainties about the exchange rates compared to fixed regimes.

Among the control variables specific to the receiving jurisdictions, infrastructure or legal and regulatory frameworks are not found to have a statistically significant relationship with the cost of sending remittances. A higher GDP per capita of the destination country is associated with higher average cost, while larger destination jurisdiction population is associated with lower costs. While the former may be an indicator of how incomes affect the price charged for the service, the latter is related to the scale. The existence of restrictions on inward P2P transfers by the receiving jurisdiction is found to be associated with lower cost of remittances. This could potentially be due to RSPs providing incentives by lowering their fees (and hence, enabling a lower average cost) in response to such restrictions for marketing purposes. Lastly, while floating exchange rate regime in the receiving jurisdiction does not have any statistically significant relationship to the cost, the existence of a currency union in the receiving jurisdiction is associated with lower average foreign exchange margins, while raising the average transfer fees.

Table B3.2 Average Cost of Sending $200 and Components

	Sender controls - Recipient FE				Recipient controls - Sender FE		
	(1) Average cost of sending $200	(2) Average fee for sending $200	(3) Average FX margin for sending $200		(4) Average cost of sending $200	(5) Average fee for sending $200	(6) Average FX margin for sending $200
Average speed of transaction (hours)	0.0005***	0.0007***	-0.0002**	Average speed of transaction (hours)	0.0002*	0.0003***	-0.0000
	[0.000]	[0.000]	[0.000]		[0.000]	[0.000]	[0.000]
No. of migrants	-0.0016**	-0.0015***	-0.0001	No. of migrants	-0.0002	-0.0001	-0.0001
	[0.001]	[0.000]	[0.000]		[0.000]	[0.000]	[0.000]
Distance (log)	0.0104	0.0071	0.0033	Distance (log)	0.0033	0.0017	0.0016
	[0.007]	[0.006]	[0.002]		[0.002]	[0.001]	[0.002]
Shared border (0/1)	-0.0164	-0.0025	-0.0138*	Shared border (0/1)	-0.0095	-0.0066	-0.0029
	[0.015]	[0.013]	[0.008]		[0.007]	[0.005]	[0.003]
Colonial relation (0/1)	0.0031	0.0041	-0.0010	Colonial relation (0/1)	-0.0056	-0.0059*	0.0004
	[0.009]	[0.007]	[0.004]		[0.005]	[0.003]	[0.004]
Common official language (0/1)	-0.0214**	-0.0078	-0.0135***	Common official language (0/1)	-0.0015	-0.0033*	0.0018
	[0.009]	[0.007]	[0.004]		[0.003]	[0.002]	[0.002]

Table B3.2 continued

	Sender controls - Recipient FE				Recipient controls - Sender FE		
	(1) Average cost of sending $200	(2) Average fee for sending $200	(3) Average FX margin for sending $200		(4) Average cost of sending $200	(5) Average fee for sending $200	(6) Average FX margin for sending $200
Share of services offered by "digital" MTOs	-0.0006***	-0.0006***	0.0000	Share of services offered by "digital" MTOs	0.0000	-0.0003***	0.0004***
	[0.000]	[0.000]	[0.000]		[0.000]	[0.000]	[0.000]
GDP per capita of sender (log)	-0.0030	-0.0056	0.0027	GDP per capita of destination (log)	0.0034**	0.0026**	0.0008
	[0.014]	[0.013]	[0.007]		[0.002]	[0.001]	[0.001]
Population of sender (log)	-0.0042	-0.0022	-0.0020	Population of destination (log)	-0.0029***	-0.0012***	-0.0017**
	[0.005]	[0.004]	[0.002]		[0.001]	[0.000]	[0.001]
Aggregate infrastructure index, sender	-0.0022**	-0.0017*	-0.0005				
	[0.001]	[0.001]	[0.000]				
Bank concentration, sender	-0.0002	-0.0001	-0.0001				
	[0.000]	[0.000]	[0.000]				
Aggregate regulatory index, sender	-0.0005**	-0.0003**	-0.0001				
	[0.000]	[0.000]	[0.000]				
				Destination jurisdiction is in a currency union (0/1)	-0.0032	0.0095**	-0.0127***
					[0.007]	[0.005]	[0.004]
Floating exchange rate, sender (de facto) (0,1)	0.0265	0.0019	0.0245**	Floating exchange rate, destination (de facto) (0,1)	0.0028	0.0016	0.0012
	[0.021]	[0.022]	[0.009]		[0.003]	[0.002]	[0.002]
Restrictions on outward P2P transfers, sender (0/1)	0.0323***	0.0247***	0.0076	Restrictions on inward P2P transfers, destination (0/1)	-0.0097***	-0.0054***	-0.0043*
	[0.011]	[0.009]	[0.006]		[0.003]	[0.002]	[0.002]
Constant	0.1939***	0.1595**	0.0344	Constant	0.0452**	0.0334***	0.0118
	[0.072]	[0.069]	[0.035]		[0.019]	[0.010]	[0.014]
Observations	113	113	113	Observations	278	278	278
R-squared	0.833	0.848	0.789	R-squared	0.757	0.847	0.440

Source: World Bank staff.
Robust standard errors are reported in brackets. *, **, and *** represent statistical significance at 10 percent, 5 percent, and 1 percent, respectively.

Appendix 6: Appendix Tables

Appendix Table 1. Aggregate Fintech Activity Index

	Agg. fintech activity index (4 components)		Agg. fintech activity index (3 components)		Investments in fintech companies	Usage of fintech credit	Usage of digital payments	Finance app. downloads
Country	Index	Rank	Index	Rank	Index	Index	Index	Index
Afghanistan	.	.	3.8	118	0.0	0.0	11.3	.
Albania	.	.	7.7	105	1.8	7.4	13.9	.
Algeria	5.5	71	6.0	111	0.0	6.9	10.9	4.3
Andorra	.	.	.	.	0.0	0.1	.	.
Angola	.	.	.	.	0.0	0.0	.	6.6
Antigua and Barbuda	.	.	.	.	.	1.6	.	.
Argentina	17.1	55	15.8	64	5.7	5.4	36.2	20.9
Armenia	.	.	12.1	84	0.8	13.4	22.2	.
Australia	69.8	7	75.8	8	50.0	79.7	97.5	51.7
Austria	36.2	26	34.5	33	16.7	9.0	77.7	41.3
Azerbaijan	.	.	.	.	0.5	.	19.4	13.3
Bahamas, The	.	.	.	.	17.1	.	.	.
Bahrain	.	.	20.7	50	6.6	0.0	55.5	.
Bangladesh	.	.	4.6	117	0.7	0.0	13.1	.
Barbados	.	.	.	.	66.9	0.6	.	8.1
Belarus	21.3	44	16.7	61	3.6	0.2	46.4	35.1
Belgium	45.8	20	44.8	22	21.3	20.4	92.7	48.8
Belize	.	.	.	.	6.0	3.3	.	.
Benin	.	.	5.7	113	0.2	0.5	16.5	.
Bermuda	.	.	.	.	33.3	0.0	.	12.8
Bhutan	.	.	.	.	0.0	0.2	.	.
Bolivia	.	.	8.0	101	0.2	11.6	12.1	.
Bosnia and Herzegovina	.	.	10.2	94	10.8	0.2	19.5	.
Botswana	.	.	13.1	77	0.0	6.6	32.6	.
Brazil	27.4	32	16.2	62	9.2	7.8	31.7	60.8
Brunei Darussalam	.	.	.	.	0.0	.	.	.
Bulgaria	17.7	53	17.1	58	10.2	11.7	29.4	19.4
Burkina Faso	.	.	.	.	.	12.7	19.0	.
Burundi	.	.	.	.	0.0	42.0	.	.

Appendix table 1 continued

	Agg. fintech activity index (4 components)		Agg. fintech activity index (3 components)		Investments in fintech companies	Usage of fintech credit	Usage of digital payments	Finance app. downloads
Country	Index	Rank	Index	Rank	Index	Index	Index	Index
Cabo Verde	.	.	.	.	.	0.3	.	.
Cambodia	.	.	12.4	80	0.7	27.2	9.4	.
Cameroon	.	.	11.3	90	0.4	19.3	14.2	.
Canada	63.4	12	70.7	10	70.3	43.1	98.7	41.5
Cayman Islands	.	.	.	.	92.5	.	.	.
Central African Republic	.	.	3.5	120	0.0	0.1	10.5	.
Chad	.	.	.	.	0.2	0.0	.	.
Chile	37.5	24	39.7	29	13.1	57.2	48.7	30.9
China	63.4	11	61.6	16	35.2	100.0	49.6	68.9
Colombia	21.0	46	21.8	45	3.8	43.8	17.9	18.6
Comoros	.	.	.	.	.	0.0	.	.
Congo, Dem. Rep.	.	.	.	.	.	9.6	10.2	.
Congo, Rep.	.	.	4.7	115	0.0	3.7	10.3	.
Costa Rica	21.2	45	16.9	59	1.8	8.7	40.1	34.3
Côte d'Ivoire	.	.	8.0	100	0.4	5.2	18.5	.
Croatia	23.9	41	22.9	43	3.9	0.9	63.9	26.7
Cuba	.	.	.	.	.	0.3	.	.
Curaçao	.	.	.	.	.	100.0	.	.
Cyprus	.	.	42.9	25	75.0	0.3	53.4	.
Czech Republic	29.8	29	30.7	37	8.0	15.8	68.4	27.0
Denmark	69.4	8	69.1	12	85.5	25.4	96.5	70.3
Dominica	.	.	.	.	.	0.9	.	.
Dominican Republic	10.4	65	7.9	103	0.5	0.7	22.4	18.1
Ecuador	7.7	68	7.2	106	1.2	5.4	15.1	9.4
Egypt, Arab Rep.	4.7	72	5.8	112	4.1	1.8	11.4	1.6
El Salvador	11.4	64	13.4	75	1.1	20.8	18.4	5.3
Equatorial Guinea	.	.	.	.	.	1.2	.	.
Eritrea	.	.	.	.	.	0.2	.	.
Estonia	.	.	87.0	3	72.7	100.0	88.2	.
Ethiopia	.	.	3.1	124	1.4	1.1	6.7	.
Finland	69.2	9	78.5	5	46.4	89.0	100.0	41.3
France	40.6	21	43.8	23	21.7	33.5	76.3	30.9
Gabon	.	.	11.6	88	0.0	0.0	34.7	.
Gambia, The	.	.	.	.	0.0	3.0	.	.
Georgia	.	.	41.6	26	5.2	100.0	19.7	.
Germany	38.2	23	40.0	28	22.1	19.2	78.6	33.0
Ghana	14.0	58	16.2	63	9.1	9.5	29.9	7.4
Greece	25.8	38	27.1	38	38.2	1.4	41.8	21.9

Appendix table 1 continued

	Agg. fintech activity index (4 components)		Agg. fintech activity index (3 components)		Investments in fintech companies	Usage of fintech credit	Usage of digital payments	Finance app. downloads
Country	Index	Rank	Index	Rank	Index	Index	Index	Index
Greenland	.	.	.	.	.	0.5	.	.
Grenada	.	.	.	.	0.0	.	.	.
Guatemala	5.8	70	6.1	109	0.2	5.6	12.6	5.0
Guinea	.	.	.	.	.	0.3	12.0	.
Guinea-Bissau	.	.	.	.	.	0.4	.	.
Guyana	.	.	.	.	0.0	.	.	.
Haiti	.	.	9.6	97	0.2	12.0	16.6	.
Honduras	.	.	6.1	110	0.2	3.1	15.0	.
Hong Kong SAR, China	64.8	10	58.1	17	100.0	3.5	70.9	84.8
Hungary	19.0	49	19.4	52	11.5	0.3	46.4	17.8
Iceland	.	.	.	.	79.4	6.2	.	.
India	18.7	51	13.6	74	22.6	8.4	9.9	33.8
Indonesia	11.6	63	7.8	104	3.9	5.9	13.7	22.8
Iran, Islamic Rep.	.	.	18.4	54	0.3	0.1	54.9	.
Iraq	.	.	.	.	.	0.7	17.2	.
Ireland	61.0	13	68.4	13	96.5	27.9	80.7	39.0
Israel	71.5	6	78.2	6	77.9	89.9	66.9	51.3
Italy	29.8	30	31.0	36	17.5	11.3	64.3	26.0
Jamaica	.	.	.	.	0.8	0.3	.	.
Japan	26.6	35	24.7	40	4.0	12.5	57.6	32.3
Jordan	.	.	14.4	73	9.3	18.9	15.0	.
Kazakhstan	21.4	43	15.6	65	0.0	8.3	38.5	38.7
Kenya	38.7	22	32.5	34	14.4	36.9	46.1	57.4
Korea, Rep.	57.7	16	43.6	24	6.7	49.0	75.1	100.0
Kosovo	.	.	.	.	.	2.7	23.8	.
Kuwait	19.3	48	18.0	56	4.6	0.1	49.3	23.3
Kyrgyz Republic	.	.	.	.	.	9.1	18.6	.
Lao PDR	.	.	3.1	123	0.0	0.8	8.5	.
Latvia	.	.	69.4	11	36.9	100.0	71.4	.
Lebanon	12.1	60	14.8	69	12.3	15.2	16.7	4.3
Lesotho	.	.	13.3	76	0.0	12.8	27.1	.
Liberia	.	.	.	.	.	29.0	15.4	.
Libya	.	.	.	.	.	.	18.8	.
Liechtenstein	.	.	.	.	86.9	0.7	.	.
Lithuania	55.9	17	64.7	14	27.9	98.0	68.2	29.6
Luxembourg	47.7	19	56.8	18	85.9	0.3	84.1	20.4
Macedonia, FYR	.	.	9.3	98	0.0	0.8	27.2	.
Madagascar	.	.	.	.	0.0	11.4	.	0.0

Appendix table 1 continued

	Agg. fintech activity index (4 components)		Agg. fintech activity index (3 components)		Investments in fintech companies	Usage of fintech credit	Usage of digital payments	Finance app. downloads
Country	Index	Rank	Index	Rank	Index	Index	Index	Index
Malawi	.	.	15.2	67	0.1	28.3	17.2	.
Malaysia	23.6	42	21.6	46	8.5	3.8	52.5	29.5
Maldives	.	.	.	.	0.0	.	.	.
Mali	.	.	14.5	71	0.0	28.2	15.3	.
Malta	.	.	56.5	19	100.0	2.3	67.2	.
Marshall Islands	.	.	.	.	33.3	.	.	.
Mauritania	.	.	.	.	.	1.9	9.8	.
Mauritius	.	.	21.4	47	37.7	0.7	25.9	.
Mexico	13.4	59	12.2	82	5.2	11.6	19.9	16.9
Moldova	.	.	17.3	57	20.8	2.1	29.1	.
Monaco	.	.	.	.	.	20.6	.	.
Mongolia	.	.	18.4	55	4.7	9.7	40.7	.
Montenegro	.	.	10.8	92	4.6	0.3	27.5	.
Morocco	.	.	3.2	121	0.7	0.6	8.4	.
Mozambique	.	.	9.7	96	0.0	7.8	21.1	.
Myanmar	.	.	3.2	122	0.4	1.2	8.1	.
Namibia	.	.	14.4	72	0.0	2.0	41.2	.
Nepal	.	.	3.8	119	0.2	2.3	8.9	.
Netherlands	61.0	14	64.0	15	55.5	42.8	93.6	51.9
New Zealand	73.2	5	81.1	4	45.0	100.0	98.4	49.6
Nicaragua	.	.	10.7	93	0.4	19.7	12.1	.
Niger	.	.	.	.	0.0	1.6	.	.
Nigeria	18.3	52	7.0	107	3.4	7.0	10.5	52.1
Norway	58.7	15	50.5	21	49.1	2.4	100.0	83.5
Oman	.	.	.	.	0.5	.	.	22.1
Pakistan	3.6	74	2.8	125	0.5	1.4	6.3	6.3
Panama	11.7	62	12.4	81	6.9	8.3	21.9	9.6
Papua New Guinea	.	.	.	.	0.0	.	.	.
Paraguay	.	.	14.6	70	0.0	25.3	18.6	.
Peru	12.1	61	8.3	99	1.9	9.1	13.8	23.6
Philippines	9.1	66	7.9	102	7.9	3.1	12.8	12.6
Poland	29.1	31	31.6	35	7.2	19.2	68.4	21.5
Portugal	25.3	40	22.9	44	10.3	3.7	54.7	32.4
Puerto Rico	.	.	.	.	.	16.5	.	.
Qatar	.	.	.	.	9.0	2.0	.	30.7
Romania	14.0	57	11.9	86	5.5	2.9	27.2	20.5
Russian Federation	27.4	33	21.3	48	4.0	1.4	58.6	45.4
Rwanda	.	.	41.5	27	1.9	100.0	22.6	.

Appendix table 1 continued

	Agg. fintech activity index (4 components)		Agg. fintech activity index (3 components)		Investments in fintech companies	Usage of fintech credit	Usage of digital payments	Finance app. downloads
Country	Index	Rank	Index	Rank	Index	Index	Index	Index
Saudi Arabia	18.8	50	19.0	53	3.5	0.0	53.5	18.3
Senegal	.	.	15.1	68	0.6	22.2	22.6	.
Serbia	.	.	11.2	91	1.3	0.7	31.6	.
Seychelles	.	.	.	.	67.0	0.4	.	.
Sierra Leone	.	.	24.2	41	0.3	61.8	10.6	.
Singapore	73.8	4	72.6	9	90.9	58.6	68.4	77.3
Slovak Republic	27.3	34	26.1	39	4.8	9.1	64.2	31.1
Slovenia	30.5	28	36.8	32	19.2	22.3	68.7	11.7
Somalia	.	.	.	.	.	3.0	.	.
South Africa	25.9	37	23.7	42	26.0	9.1	35.9	32.6
South Sudan	.	.	.	.	.	6.3	.	.
Spain	37.4	25	38.3	30	29.8	15.3	69.7	34.8
Sri Lanka	7.5	69	4.8	114	0.6	0.0	13.7	15.5
St. Lucia	.	.	.	.	0.0	1.1	.	.
Sudan	.	.	.	.	0.0	0.2	.	.
Suriname	.	.	.	.	.	0.6	.	.
Swaziland	.	.	.	.	0.0	2.3	.	.
Sweden	78.3	3	77.0	7	89.3	44.1	97.6	82.3
Switzerland	52.4	18	54.2	20	74.0	10.9	77.8	46.8
Taiwan, China	.	.	.	.	.	.	49.0	.
Tajikistan	.	.	.	.	.	31.2	15.9	.
Tanzania	.	.	11.7	87	0.3	9.1	25.8	.
Thailand	17.6	54	10.1	95	2.4	0.9	27.1	40.1
Timor-Leste	.	.	.	.	.	11.1	.	.
Togo	.	.	12.1	85	0.3	19.2	16.9	.
Trinidad and Tobago	.	.	12.2	83	1.6	0.2	34.8	.
Tunisia	4.0	73	4.6	116	1.8	0.9	11.3	2.0
Turkey	25.7	39	20.1	51	4.8	0.5	55.0	42.5
Turkmenistan	.	.	.	.	.	.	20.4	.
Uganda	.	.	21.3	49	2.3	37.1	24.5	.
Ukraine	15.5	56	11.3	89	1.8	1.3	30.8	27.9
United Arab Emirates	35.2	27	37.7	31	28.8	11.6	72.7	27.9
United Kingdom	84.3	2	95.8	2	100.0	100.0	87.4	49.7
United States	87.4	1	96.6	1	93.3	100.0	96.5	59.9
Uruguay	20.4	47	16.7	60	14.9	3.5	31.7	31.5
Uzbekistan	.	.	.	.	0.1	.	13.7	11.9
Vanuatu	.	.	.	.	.	1.7	.	.
Venezuela, RB	26.6	36	15.6	66	0.3	0.0	46.5	59.4

Appendix table 1 continued

	Agg. fintech activity index (4 components)		Agg. fintech activity index (3 components)		Investments in fintech companies	Usage of fintech credit	Usage of digital payments	Finance app. downloads
Country	Index	Rank	Index	Rank	Index	Index	Index	Index
Vietnam	8.9	67	6.5	108	2.8	1.1	15.7	16.1
Virgin Islands (U.S.)	.	.	.	.	.	3.3	.	.
West Bank and Gaza	.	.	.	.	0.5	50.7	.	.
Yemen, Rep.	.	.	.	.	0.0	3.4	.	.
Zambia	.	.	12.5	79	0.5	11.5	25.5	.
Zimbabwe	.	.	12.7	78	1.0	8.5	28.5	.

Source: World Bank staff.
This table shows, for all countries with available data, the value of the aggregate fintech activity index (with 4 and 3 sub-components) as well as the value of each of its sub-components. All indexes range between 0 and 100.

Appendix Table 2. Country Coverage for the Regression Analysis

Armenia	Honduras	Norway
Australia	Hong Kong SAR, China	Pakistan
Azerbaijan	Hungary	Peru
Belgium	India	Poland
Brazil	Ireland	Portugal
Bulgaria	Israel	Russian Federation
Chile	Italy	Rwanda
China	Jordan	Serbia
Costa Rica	Kazakhstan	Slovak Republic
Czech Republic	Kenya	Slovenia
Denmark	Korea, Rep.	South Africa
Dominican Republic	Latvia	Spain
Ecuador	Lithuania	Sweden
Egypt, Arab Rep.	Malta	Switzerland
El Salvador	Mauritius	Thailand
Estonia	Moldova	Turkey
Finland	Mongolia	Ukraine
France	Montenegro	Vietnam
Georgia	Morocco	Zambia
Germany	Myanmar	Zimbabwe
Greece	Netherlands	
Guatemala	Nigeria	

Source: World Bank staff.
This table lists all the countries included in the regression analysis shown in tables 2, 3, and 4.

Appendix Table 3. Regression Analysis with Expanded Sample of Countries: Aggregate Fintech Activity Index

Expanded sample of countries														
	Index with 4 components							Index with 3 components						
	1	2	3	4	5*	6*	7*	8	9	10	11	12*	13*	14*
Ln (GDP per capita)	0.480**	0.636***	0.895***	0.177	0.378*	0.746***	0.276	0.546**	0.679***	0.882***	0.361	0.414**	0.734***	0.308
	[0.216]	[0.101]	[0.136]	[0.224]	[0.205]	[0.093]	[0.197]	[0.228]	[0.118]	[0.148]	[0.265]	[0.168]	[0.094]	[0.194]
Share young population	0.097***	-0.020	0.060	0.032	-0.008	-0.001	-0.007	-0.008	-0.044	0.010	-0.001	-0.023**	-0.026*	-0.026*
	[0.036]	[0.014]	[0.039]	[0.039]	[0.016]	[0.014]	[0.012]	[0.026]	[0.027]	[0.042]	[0.033]	[0.011]	[0.015]	[0.015]
Share urban population	-0.002	-0.001	-0.000	-0.000	-0.002	-0.000	-0.000	-0.007	-0.006	-0.009	-0.006	-0.010*	-0.006	-0.009
	[0.008]	[0.006]	[0.009]	[0.008]	[0.007]	[0.007]	[0.006]	[0.007]	[0.005]	[0.009]	[0.009]	[0.006]	[0.006]	[0.007]
Infrastructure:														
ICT infrastructure	0.049**			0.059***	0.034**		0.032*	0.027			0.056**	0.033***		0.045***
	[0.021]			[0.022]	[0.016]		[0.019]	[0.022]			[0.025]	[0.013]		[0.017]
Financial infrastructure	0.005			0.012*	0.000		0.004	0.004			0.012*	-0.002		0.002
	[0.007]			[0.007]	[0.006]		[0.007]	[0.006]			[0.007]	[0.006]		[0.007]
Financial development:														
Banking system development		-0.013*		-0.035**			-0.013		-0.019***		-0.044***			-0.025***
		[0.007]		[0.015]			[0.008]		[0.007]		[0.015]			[0.008]
Capital market development		0.018***		0.023***			0.017***		0.019***		0.021***			0.018***
		[0.004]		[0.007]			[0.005]		[0.004]		[0.008]			[0.005]
Policy environment:														
E-money laws			0.002	0.010**		0.003	0.000			0.000	0.008		0.002	0.000
			[0.003]	[0.005]		[0.002]	[0.002]			[0.004]	[0.005]		[0.003]	[0.003]
Consumer protection index			0.002	-0.017*		0.004	-0.000			0.003	-0.010		0.003	-0.001
			[0.006]	[0.010]		[0.003]	[0.003]			[0.008]	[0.011]		[0.003]	[0.003]
E-KYC			0.001	0.004		-0.005	-0.002			0.002	0.005		-0.001	0.000
			[0.004]	[0.003]		[0.004]	[0.003]			[0.004]	[0.005]		[0.004]	[0.004]
Observations	55	70	51	46	64	68	62	78	110	73	63	99	107	91
(Pseudo) R-squared	0.126	0.115	0.111	0.124	0.108	0.101	0.111	0.137	0.130	0.133	0.142	0.133	0.125	0.135

Source: World Bank staff.

This table shows the cross-sectional regression analysis of the aggregate fintech activity index and its potential drivers. The first six columns show the regressions based on the aggregate fintech activity index with 4 sub-components, whereas the last 6 columns show the regressions for the index with 3 sub-components. The columns marked with * incorporate additional data for individual countries with missing GPSS data on the indexes of payments infrastructure and the policy environment. These complementary data were collected in the course of several projects conducted by the World Bank covering the same time period as the GPSS data used in these indexes. These additional data are available only for a sub-set of the indicators analyzes. Hence, for these specifications, we exclude the following indicators from the estimations: interoperability of mobile money and quality of retail payment systems in the payment infrastructure index; deposit insurance, disclosure requirements, and dispute resolution in the consumer protection index. Robust standard errors are reported in brackets. *, **, and *** represent statistical significance at 10 percent, 5 percent, and 1 percent, respectively.

Appendix Table 4A. Regression Analysis: Equity Investments in Fintech Companies

Expanded sample of countries							
	1	2	3	4	5*	6*	7*
LN (GDP per capita)	1.040**	1.212***	1.673***	0.802**	0.898**	1.363***	0.665*
	[0.452]	[0.206]	[0.248]	[0.377]	[0.436]	[0.180]	[0.386]
Share young population	0.043	-0.035	0.080	0.057	-0.007	-0.016	-0.011
	[0.054]	[0.023]	[0.059]	[0.077]	[0.021]	[0.023]	[0.023]
Share urban population	-0.015	-0.011	-0.006	-0.017	-0.020	-0.003	-0.020
	[0.015]	[0.010]	[0.016]	[0.016]	[0.014]	[0.014]	[0.014]
Infrastructure:							
ICT infrastructure	0.047			0.074**	0.052*		0.062*
	[0.040]			[0.037]	[0.029]		[0.036]
Financial infrastructure	-0.004			0.008	-0.016		-0.008
	[0.011]			[0.010]	[0.012]		[0.012]
Financial development:							
Banking system development		-0.031**		-0.062***			-0.042**
		[0.013]		[0.020]			[0.017]
Capital market development		0.037***		0.041***			0.038***
		[0.008]		[0.011]			[0.010]
Policy environment:							
E-money laws			-0.000	0.012		0.000	-0.001
			[0.005]	[0.008]		[0.004]	[0.004]
Consumer protection index			-0.005	-0.028*		0.001	-0.004
			[0.010]	[0.015]		[0.006]	[0.005]
E-KYC			-0.000	0.007		-0.003	0.004
			[0.007]	[0.006]		[0.005]	[0.005]
Observations	78	116	79	63	97	111	89
(Pseudo) R-squared	0.268	0.316	0.299	0.295	0.285	0.276	0.291

Source: World Bank staff.
This table shows the cross-sectional regression analysis of the index representing equity investments in fintech companies on the potential drivers of fintech activity. The columns marked with * incorporate additional data for individual countries with missing GPSS data on the indexes of payments infrastructure and the policy environment. These complementary data were collected in the course of several projects conducted by the World Bank covering the same time period as the GPSS data used in these indexes. These additional data are available only for a sub-set of the indicators analyzes. Hence, for these specifications, we exclude the following indicators from the estimations: interoperability of mobile money and quality of retail payment systems in the payment infrastructure index; deposit insurance, disclosure requirements, and dispute resolution in the consumer protection index. Offshore financial centers are excluded from the estimations. Robust standard errors are reported in brackets. *, **, and *** represent statistical significance at 10 percent, 5 percent, and 1 percent, respectively.

Appendix Table 4B. Alternative Regression Analysis: Usage of Fintech Credit

Expanded sample of countries									
	1	2	3	4	5	6*	7*	8*	9*
LN (GDP per capita)	-0.213	0.175	0.368*	-0.495	-0.600	-0.360	0.145	-0.568	-0.596
	[0.504]	[0.216]	[0.218]	[0.784]	[0.610]	[0.389]	[0.163]	[0.534]	[0.495]
Share young population	-0.102	-0.112**	-0.066	-0.054	-0.107	-0.090**	-0.140***	-0.079	-0.096*
	[0.063]	[0.044]	[0.073]	[0.084]	[0.091]	[0.042]	[0.052]	[0.060]	[0.057]
Share urban population	-0.002	-0.000	-0.012	-0.004	-0.008	-0.004	-0.005	-0.009	-0.010
	[0.014]	[0.011]	[0.015]	[0.018]	[0.019]	[0.012]	[0.012]	[0.016]	[0.016]
Infrastructure:									
ICT infrastructure	0.036			0.098	0.135***	0.046		0.086*	0.093**
	[0.040]			[0.069]	[0.050]	[0.029]		[0.045]	[0.044]
Financial infrastructure	0.017			0.035*		0.011		0.019	
	[0.014]			[0.021]		[0.013]		[0.017]	
Payment systems infr.					0.009				0.009
					[0.011]				[0.014]
Depth of credit information					0.078***				0.037*
					[0.021]				[0.021]
Credit registry coverage					0.006				-0.000
					[0.006]				[0.005]
Financial development:									
Banking system development		-0.024*		-0.078**	-0.092***			-0.046**	-0.039*
		[0.013]		[0.037]	[0.030]			[0.022]	[0.022]
Capital market development		0.023***		0.028	0.030*			0.025*	0.020
		[0.009]		[0.020]	[0.016]			[0.015]	[0.014]
Policy environment:									
E-money laws			0.001	0.014	0.015		-0.004	-0.003	-0.000
			[0.006]	[0.012]	[0.013]		[0.004]	[0.008]	[0.007]
Consumer protection index			0.003	-0.014	-0.019		0.010*	0.003	0.002
			[0.014]	[0.026]	[0.021]		[0.005]	[0.008]	[0.007]
E-KYC			0.009	0.016	0.021*		-0.005	0.002	0.003
			[0.010]	[0.012]	[0.011]		[0.007]	[0.009]	[0.008]
Observations	82	118	81	63	63	102	123	91	91
(Pseudo) R-squared	0.0684	0.0588	0.0634	0.117	0.191	0.0602	0.0675	0.0908	0.118

Source: World Bank staff.
This table shows the cross-sectional regression analysis of the index representing fintech credit on the potential drivers of fintech activity. The columns marked with * incorporate additional data for individual countries with missing GPSS data on the indexes of payments infrastructure and the policy environment. These complementary data were collected in the course of several projects conducted by the World Bank covering the same time period as the GPSS data used in these indexes. These additional data are available only for a sub-set of the indicators analyzes. Hence, for these specifications, we exclude the following indicators from the estimations: interoperability of mobile money and quality of retail payment systems in the payment infrastructure index; deposit insurance, disclosure requirements, and dispute resolution in the consumer protection index. Robust standard errors are reported in brackets. *, **, and *** represent statistical significance at 10 percent, 5 percent, and 1 percent, respectively.

Appendix Table 4C. Alternative Regression Analysis: Usage of Digital Payments

	Expanded sample of countries								
	1	2	3	4	5	6*	7*	8*	9*
LN (GDP per capita)	0.962***	0.983***	1.104***	0.981***	0.969***	0.835***	0.989***	0.867***	0.819***
	[0.188]	[0.118]	[0.149]	[0.228]	[0.203]	[0.152]	[0.092]	[0.199]	[0.189]
Share young population	-0.023	-0.036	0.006	0.017	0.039	-0.022*	-0.020	-0.028*	-0.026*
	[0.018]	[0.022]	[0.034]	[0.039]	[0.038]	[0.013]	[0.014]	[0.016]	[0.015]
Share urban population	-0.007	-0.010*	-0.010	-0.011	-0.009	-0.013**	-0.011*	-0.013**	-0.012**
	[0.007]	[0.005]	[0.008]	[0.008]	[0.007]	[0.006]	[0.006]	[0.006]	[0.006]
Infrastructure:									
ICT Infrastructure	0.006			0.038**	0.040**	0.017*		0.025*	0.028**
	[0.015]			[0.016]	[0.017]	[0.010]		[0.014]	[0.013]
Financial infrastructure	-0.000			0.009		-0.006		-0.002	
	[0.005]			[0.005]		[0.005]		[0.005]	
Interoperability index					0.001				0.001
					[0.002]				[0.003]
Quality of retail payment systems index					0.006				-
					[0.004]				-
Agent network index					0.004**				0.003*
					[0.002]				[0.002]
Credit information systems index					-0.000				-0.005
					[0.004]				[0.003]
Financial development:									
Banking system development		-0.013*		-0.039***	-0.034**			-0.017**	-0.016*
		[0.007]		[0.015]	[0.015]			[0.008]	[0.008]
Capital market development		0.011**		0.014**	0.011*			0.009**	0.009**
		[0.004]		[0.007]	[0.006]			[0.005]	[0.005]
Policy environment:									
E-money laws			-0.000	0.004	0.005*		0.002	0.002	0.001
			[0.003]	[0.003]	[0.003]		[0.002]	[0.002]	[0.002]
Consumer protection index			0.006	-0.002	-0.005		0.002	-0.002	-0.003
			[0.005]	[0.005]	[0.005]		[0.003]	[0.003]	[0.003]
E-KYC			0.001	0.005	0.005		-0.001	0.000	-0.000
			[0.003]	[0.003]	[0.003]		[0.003]	[0.003]	[0.003]
Observations	82	111	76	64	64	102	114	92	92
(Pseudo) R-squared	0.214	0.189	0.217	0.218	0.222	0.200	0.197	0.198	0.201

Source: World Bank staff.
This table shows the cross-sectional regression analysis of the index representing usage of digital financial services (focused mostly on digital payments) on the potential drivers of fintech activity. The columns marked with * incorporate additional data for individual countries with missing GPSS data on the indexes of payments infrastructure and the policy environment. These complementary data were collected in the course of several projects conducted by the World Bank covering the same time period as the GPSS data used in these indexes. These additional data are available only for a sub-set of the indicators analyzes. Hence, for these specifications, we exclude the following indicators from the estimations: interoperability of mobile money and quality of retail payment systems in the payment infrastructure index; deposit insurance, disclosure requirements, and dispute resolution in the consumer protection index. Robust standard errors are reported in brackets. *, **, and *** represent statistical significance at 10 percent, 5 percent, and 1 percent, respectively.

Appendix Table 4D. Alternative Regression Analysis: Financial App Downloads

Expanded sample of countries									
	1	2	3	4	5	6*	7*	8*	9*
LN (GDP per capita)	0.066	0.229	0.553***	-0.097	-0.040	0.180	0.372***	0.064	0.181
	[0.259]	[0.169]	[0.180]	[0.305]	[0.309]	[0.320]	[0.116]	[0.358]	[0.361]
Share young population	0.098	-0.019**	0.103**	0.092	0.060	-0.011	-0.001	-0.005	-0.015
	[0.060]	[0.009]	[0.049]	[0.082]	[0.084]	[0.017]	[0.018]	[0.020]	[0.019]
Share urban population	0.006	0.005	0.005	0.010	0.011	0.006	0.006	0.011	0.010
	[0.010]	[0.008]	[0.011]	[0.010]	[0.011]	[0.010]	[0.009]	[0.009]	[0.009]
Total app. downloads					0.002				0.003**
					[0.001]				[0.001]
Infrastructure:									
ICT infrastructure	0.050			0.035	0.036	0.016		0.001	0.005
	[0.031]			[0.030]	[0.030]	[0.027]		[0.029]	[0.030]
Financial infrastructure	0.009			0.010	0.008	0.006		0.010	0.005
	[0.007]			[0.008]	[0.008]	[0.009]		[0.008]	[0.008]
Financial development:									
Banking system development		-0.009		-0.017	-0.023			-0.004	-0.010
		[0.010]		[0.021]	[0.020]			[0.011]	[0.011]
Capital market development		0.020***		0.026***	0.025**			0.022***	0.019***
		[0.005]		[0.009]	[0.010]			[0.006]	[0.007]
Policy environment:									
E-money laws			0.005	0.008*	0.007		0.004	0.002	0.002
			[0.003]	[0.005]	[0.005]		[0.003]	[0.002]	[0.002]
Consumer protection index			0.007	-0.004	-0.006		0.003	-0.001	-0.001
			[0.006]	[0.011]	[0.010]		[0.004]	[0.005]	[0.005]
E-KYC			0.004	0.003	0.001		-0.001	-0.002	-0.003
			[0.004]	[0.004]	[0.005]		[0.004]	[0.005]	[0.004]
Observations	57	74	54	47	47	66	71	63	63
(Pseudo) R-squared	0.0702	0.0682	0.0661	0.0849	0.0874	0.0467	0.0475	0.0624	0.0676

Source: World Bank staff.
This table shows the cross-sectional regression analysis of the index representing financial app downloads on the potential drivers of fintech activity. The columns marked with * incorporate additional data for individual countries with missing GPSS data on the indexes of payments infrastructure and the policy environment. These complementary data were collected in the course of several projects conducted by the World Bank covering the same time period as the GPSS data used in these indexes. These additional data are available only for a sub-set of the indicators analyzes. Hence, for these specifications, we exclude the following indicators from the estimations: interoperability of mobile money and quality of retail payment systems in the payment infrastructure index; deposit insurance, disclosure requirements, and dispute resolution in the consumer protection index. Robust standard errors are reported in brackets. *, **, and *** represent statistical significance at 10 percent, 5 percent, and 1 percent, respectively.

Appendix Table 5. Alternative Regression Analysis: Bank vs. Non-Bank Financial App Downloads

Expanded sample of countries								
	Non-bank app downloads				Bank app downloads			
	1	2	3*	4*	5	6	7*	8*
Ln (GDP per capita)	-0.050	0.008	0.062	0.123	-0.092	-0.161	-0.081	-0.116
	[0.351]	[0.358]	[0.324]	[0.324]	[0.456]	[0.477]	[0.317]	[0.330]
Share young population	0.169**	0.145*	0.099*	0.064	0.265***	0.302***	0.182***	0.207***
	[0.076]	[0.080]	[0.057]	[0.057]	[0.076]	[0.091]	[0.064]	[0.068]
Share urban population	0.001	0.002	0.004	0.005	0.051***	0.050***	0.042***	0.041***
	[0.010]	[0.010]	[0.009]	[0.009]	[0.011]	[0.011]	[0.010]	[0.010]
Total app. downloads		0.002		0.002		-0.002		-0.002
		[0.002]		[0.002]		[0.002]		[0.002]
Infrastructure:								
ICT infrastructure	0.078***	0.078***	0.051**	0.052**	0.017	0.016	0.017	0.016
	[0.027]	[0.027]	[0.020]	[0.020]	[0.036]	[0.038]	[0.022]	[0.023]
Financial infrastructure	-0.001	-0.003	-0.006	-0.011	0.010	0.013	0.016	0.019*
	[0.009]	[0.009]	[0.008]	[0.008]	[0.012]	[0.011]	[0.011]	[0.010]
Financial development:								
Banking system development	-0.017	-0.021	-0.011	-0.016	0.044**	0.050**	0.030*	0.033*
	[0.021]	[0.022]	[0.013]	[0.014]	[0.021]	[0.024]	[0.017]	[0.018]
Capital market development	0.024**	0.023**	0.021***	0.019***	-0.007	-0.005	0.002	0.004
	[0.010]	[0.010]	[0.007]	[0.007]	[0.010]	[0.010]	[0.009]	[0.009]
Policy environment:								
E-money laws	0.007	0.006	0.004	0.002	0.008	0.010	0.010***	0.011***
	[0.005]	[0.005]	[0.004]	[0.003]	[0.006]	[0.007]	[0.004]	[0.004]
Consumer protection index	-0.006	-0.007	-0.005	-0.005	0.001	0.002	-0.000	0.000
	[0.011]	[0.011]	[0.005]	[0.005]	[0.011]	[0.012]	[0.005]	[0.005]
E-KYC	0.008	0.007	0.009	0.008	0.010**	0.012**	0.007	0.008
	[0.006]	[0.007]	[0.006]	[0.006]	[0.005]	[0.006]	[0.005]	[0.005]
Observations	47	47	59	59	47	47	59	59
(Pseudo) R-squared	0.136	0.138	0.121	0.123	0.168	0.171	0.136	0.137

Source: World Bank staff.
This table shows the cross-sectional regression analysis of the index representing financial app downloads on the potential drivers of fintech activity. The left panel shows the regressions for the index of non-bank financial app downloads, whereas the right panel shows the regressions for the index of commercial bank app downloads. Both indexes are constructed based on the number of app downloads as a share of the population. The columns marked with * incorporate additional data for individual countries with missing GPSS data on the indexes of payments infrastructure and the policy environment. These complementary data were collected in the course of several projects conducted by the World Bank covering the same time period as the GPSS data used in these indexes. These additional data are available only for a sub-set of the indicators analyzes. Hence, for these specifications, we exclude the following indicators from the estimations: interoperability of mobile money and quality of retail payment systems in the payment infrastructure index; deposit insurance, disclosure requirements, and dispute resolution in the consumer protection index. Robust standard errors are reported in brackets. *, **, and *** represent statistical significance at 10 percent, 5 percent, and 1 percent, respectively.

Appendix Table 6. Regression Analysis: Usage of Digital Payments

	Using only household data									
	1	2	3	4	5	6	7	8	9	10
LN (GDP per capita)	1.042***	1.013***	0.747**	1.009***	0.728**	0.702**	0.621*	0.973***	0.936***	1.075***
	[0.171]	[0.180]	[0.297]	[0.183]	[0.295]	[0.281]	[0.338]	[0.340]	[0.298]	[0.352]
Share young population								0.028	0.061	0.018
								[0.054]	[0.053]	[0.060]
Share urban population								-0.017	-0.014	-0.028**
								[0.011]	[0.010]	[0.013]
Agg. infrastructure index	0.026**	0.025**		0.031*						
	[0.013]	[0.013]		[0.016]						
ICT infrastructure			0.039		0.044*	0.048*	0.068**	0.045**	0.051**	0.067**
			[0.025]		[0.024]	[0.026]	[0.029]	[0.023]	[0.025]	[0.029]
Financial infrastructure			0.011*		0.014*			0.013		
			[0.007]		[0.008]			[0.008]		
Interoperability index						0.002	0.002		0.001	0.000
						[0.003]	[0.003]		[0.003]	[0.003]
Quality of retail payment systems index						0.011*	0.011*		0.010**	0.009
						[0.006]	[0.006]		[0.005]	[0.005]
Agent network index						0.004	0.007**		0.004	0.005
						[0.003]	[0.004]		[0.003]	[0.004]
Credit information systems index						0.002	0.003		0.001	0.006
						[0.005]	[0.006]		[0.005]	[0.006]
Agg. financial dev. index	-0.051**									
	[0.026]									
Banking system development		-0.038**	-0.043**	-0.041**	-0.046**	-0.041**	-0.067***	-0.048**	-0.041*	-0.074***
		[0.019]	[0.019]	[0.020]	[0.020]	[0.020]	[0.022]	[0.022]	[0.021]	[0.022]
Capital market development		0.016*	0.017*	0.016*	0.018*	0.014	0.029***	0.018*	0.013	0.030***
		[0.009]	[0.009]	[0.009]	[0.009]	[0.008]	[0.010]	[0.010]	[0.009]	[0.010]
Agg. regulatory index	0.010**	0.011**	0.009*							
	[0.005]	[0.005]	[0.005]							
E-money laws				0.007*	0.007*	0.009**	0.003	0.007	0.010**	0.003
				[0.004]	[0.004]	[0.004]	[0.005]	[0.005]	[0.004]	[0.006]
E-KYC				0.005	0.004	0.004	0.006	0.005	0.005	0.005
				[0.004]	[0.004]	[0.004]	[0.006]	[0.004]	[0.004]	[0.006]
Consumer protection index				-0.004	-0.006	-0.010		-0.003	-0.008	
				[0.008]	[0.008]	[0.008]		[0.008]	[0.008]	
Alternative consumer protection index							-0.006			-0.004
							[0.007]			[0.007]
Payment systems regulatory index										
Existence of deposit insurance							0.003			0.001
							[0.005]			[0.004]
Disclosure requirement index							-0.011**			-0.008
							[0.005]			[0.005]
Dispute resolution index							0.008			0.009
							[0.005]			[0.006]
Oversight (risk management) index							-0.006			-0.003
							[0.006]			[0.006]
Simplified due diligence index							0.000			0.000
							[0.003]			[0.003]
Observations	64	64	64	64	64	64	57	64	64	57
(Pseudo) R-squared	0.204	0.205	0.207	0.206	0.208	0.217	0.254	0.213	0.221	0.262

Source: World Bank staff.
This table shows the cross-sectional regression analysis of the index representing the usage of digital financial services (focused mostly on digital payments based on household data) on the potential drivers of fintech activity. Robust standard errors are reported in brackets. *, **, and *** represent statistical significance at 10 percent, 5 percent, and 1 percent, respectively.

Appendix Table 7. Aggregate Fintech Activity Index: Decomposing Banking System Development

	Index with 4 sub-components			Index with 3 sub-components		
	1	2	3	4	5	6
Ln (GDP per capita)	0.662***	0.648***	0.624***	0.715***	0.713***	0.724***
	[0.142]	[0.168]	[0.159]	[0.203]	[0.199]	[0.207]
Share young population	0.023	0.053	0.064*	-0.023	0.007	0.015
	[0.036]	[0.039]	[0.037]	[0.042]	[0.043]	[0.046]
Share urban population	0.000	0.002	0.003	-0.005	-0.002	-0.008
	[0.007]	[0.008]	[0.010]	[0.007]	[0.008]	[0.009]
Infrastructure:						
Agg. infrastructure index	0.016	0.012	0.011	0.013	0.012	0.013
	[0.017]	[0.016]	[0.016]	[0.017]	[0.016]	[0.018]
Financial development:						
Banking system development						
Access	-0.014**			-0.012*		
	[0.006]			[0.006]		
Depth		-0.010			-0.020**	
		[0.007]			[0.008]	
Efficiency			0.007			-0.010
			[0.011]			[0.013]
Capital market development	0.015***	0.020***	0.012**	0.009	0.023***	0.012*
	[0.005]	[0.006]	[0.005]	[0.006]	[0.008]	[0.007]
Policy environment:						
Agg. regulatory index	0.002	0.005	0.003	0.003	0.007	0.005
	[0.005]	[0.005]	[0.005]	[0.007]	[0.007]	[0.007]
Observations	47	48	49	64	65	66
R-squared	0.118	0.126	0.126	0.131	0.144	0.141

Source: World Bank staff.
This table shows the cross-sectional regression analysis of the aggregate fintech activity index and its potential drivers. The first three columns show the regressions based on the aggregate fintech activity index with 4 sub-components, whereas the last three columns show the regressions for the index with 3 sub-components. Robust standard errors are reported in brackets. *, **, and *** represent statistical significance at 10 percent, 5 percent, and 1 percent, respectively.

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