High-Speed Internet, Financial Technology and Banking in Africa*

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Abstract

This paper provides empirical evidence on the effect of high-speed internet on financial technology and banking in Africa. Our test combines data on 551 banks and 28,171 firms with the staggered arrival of fibre-optic submarine cables in Africa. High-speed internet promoted private-sector lending by banks, and credit and sales by firms. These results are consistent with an extensive adoption of financial technologies, like real-time gross settlement systems (RTGS), lowering transaction costs in African interbank markets. We find that liquidity management considerably changed for banks being weak interbank users prior to high-speed internet. In fact, such banks lowered their internal liquidity hoarding by 10%, increased interbank transactions by 40% and expanded lending by 37%. Analogously, firms in countries with weak pre-existing interbank markets presented stronger effects at the cable arrival. These results are consistent with high-speed internet promoting financial technology adoption, liquidity and credit.

JEL: G2, G21, O16, O12
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1 Introduction

How does financial technology, or FinTech, shape the business of banking? A review by Goldstein et al. (2019) highlights that financial technology transforms business "outside" the bank, inducing more competition. As fintechs lower entry costs, more companies challenge banks, and a growing literature shows that this is taking place in mortgage markets (Buchak et al. (2018), Fuster et al. (2019)), consumer credit (Bartlett et al. (2018), Tang (2019)), credit scoring and screening (Berg et al. (2018), Hertzberg et al. (2018)), and investment management (Abis (2017), D'Acunto et al. (2019)), among others. However, there is still limited understanding and quantitative evidence which clarifies whether financial technology shapes business "inside" the bank.

In this research, we offer two empirical contributions on the relationship between high-speed internet, financial technology and banking. First, we show that the arrival of high-speed internet led to an expansion of banking and firm credit in Africa and quantify the size of this effect. Second, we find evidence in line with high-speed internet promoting the adoption of novel financial technologies, transforming the size and liquidity of interbank markets. This mechanism follows a critical theoretical insight à la Coase (1960): innovative financial technologies can lower transaction costs on the interbank market and generate market integration. In turn, this improves risk-sharing, reduces liquidity risk and stimulates private-sector lending, especially over the long-term (Choudhary and Limodio (2017)).[1]

As Augereau and Greenstein (2001) observe, high-speed internet promotes the mass adoption of information and communication technologies (ICT), which can stimulate the introduction of novel financial technologies like the real-time gross settlement system (RTGS), as shown by Bech and Hobijn (2006). As a result, both the access and liquidity of the interbank market can increase as the speed of transactions increases (Biais et al. (2015), Farboodi and Veldkamp (2019)) and telecommunication costs plummet (Steinwender (2018)). Therefore, while high-speed internet can directly improve business opportunities (Hjort and Poulsen (2019)), it can also have a separate effect on liquidity markets, leading banks to: 1) use more and more frequently the interbank market; 2) reduce liquidity hoarding and promote lending.

[1]In a model à la Bolton et al. (2011) and Heider et al. (2015), banks hold an optimal amount of inside liquidity (by hoarding liquid assets) and outside liquidity (through the interbank market), by equalizing the respective marginal costs.

To study this question, we face a particularly challenging empirical constraint: the power of the test. Both faster internet connections and novel financial technologies tend to be gradually adopted over time, as marginal improvements can be very lucrative, which makes statistical power a central problem. For this reason, we focus on a unique natural experiment: the introduction of high-speed internet technology in Africa. This took place through the installation of fibre-optic submarine cables connecting Asia and Europe to America, as also studied by Eichengreen et al. (2016) and Hjort and Poulsen (2019), and this offers ample power for two reasons. First, fibre-optic technology generated a 98% decline in the cost of operating ICT and RTGS compared to satellite technology (Detecon (2013)), that was the standard technology used by all African banks (African Development Fund (2002)). Second, African financial systems present considerable transaction costs in interbank markets, making this technological shock particularly likely to change banks' behaviour. This latter element is evident from Figure 1, which shows two pictures consistent with the high implied transaction costs and weakness of liquidity markets in Africa. The left panel shows a scatterplot correlating an indicator of interbank market activity with GDP per capita. The positive relation between the two variables clarifies that poorer countries present underdeveloped interbank markets and that, among low-income countries, those in Africa (indicated with a square) present the weakest markets. The right panel shows that African banks hoard vast amounts of liquid assets, between 45 and 55 per cent of their liabilities, which may be justified by the low activity of local interbank markets.

We are interested in studying two specific questions: 1) How does the introduction of high-speed internet affect banking and firm credit in Africa? 2) Does the introduction of high-speed internet promote interbank markets by reducing transaction costs? To answer these questions, we combine three comprehensive datasets. First, we track the exact geography and timing of submarine cable arrival in Africa between 2000 and 2013. Second, we gather a bank-level dataset following 551 African banks and containing information on their balance sheets, including liquid assets, interbank activities and lending from Bankscope and BankFocus. Third, we construct a dataset following 28,171 firms in Africa from the World Bank Enterprise Surveys and observe their access to finance, credit, loan maturities, sales and other variables.

In our identification, we exploit the staggered arrival of the submarine cables across Africa and proceed in four steps. First, we propose an event-study design and analyze the five-year window around the cable arrival. Our results show that we cannot reject the existence of parallel trends before the treatment. Treated banks, receiving the cable, and control, not receiving the cable, are not statistically different before the cable arrival for any of the variables under consideration (interbank activity, liquidity hoarding and lending). However, after the cable arrival, treated banks increase lending, use more extensively the interbank market and lower liquidity hoarding.

Second, we employ a difference-in-difference specification and code a dummy taking unit value in a country in the year of cable arrival and the subsequent ones. This regression is useful to quantify the effect of submarine cables on the main dependent variables: we find that private-sector lending increases by 15.7%, with interbank assets and liabilities growing by 20.2% and liquidity hoarding declining by 9.6%. We also explore a specification pointing toward an improvement in the functioning of the interbank market. In fact, for a limited subset of banks, we verify that the maturity of interbank transactions exhibits a notable increase in short-term exchanges, in line with banks using more and more frequently the interbank market.

Third, we analyze a crucial cross-sectional heterogeneity, which allows to further investigate the mechanism on the effects of high-speed internet on interbank markets. We suppose that the adoption of the fibre-optic technology should have a stronger differential impact on banks that present higher transaction costs ex-ante. This prediction is tested by defining a dummy for banks that were weak users of the interbank market before the arrival of the submarine cable. We find that nearly all of our effects are due to these particular banks becoming active on the interbank market, even once we include country $\times$ year fixed effects. These results are in line with our previous findings: banks that were weak users of the interbank market before the arrival of high-speed internet, lower their liquidity hoarding, increase their use of the interbank market and increase lending.

Finally, we explore firm-level data to investigate how high-speed internet affected firms, whether it generated a distinct effect on credit and whether there is a relation between high-speed internet, interbank markets and firm outcomes. We structure this exercise through two tests. In the first, we verify that firms in countries that were experiencing the arrival of the submarine cable exhibit an increase in their access to finance, bank credit, loan maturities and sales. In the second, we note that such an impact should be stronger in those countries presenting weak interbank markets before the arrival of the submarine cable. Indeed, we observe that the arrival of high-speed internet countries with weak pre-existing interbank markets led to a 16% increase in access to finance, a 9.7% higher likelihood of receiving a bank loan, 41% longer loan maturities and an expansion of 3 times in yearly sales.[2]

To verify the robustness of our results, we devote an extended section and appendix to explore alternative empirical specifications and explanations. First, we show that while the event studies on banks show a positive and immediate effect of high-speed internet on banking, we cannot reject an instantaneous zero impact of the cable arrival on GDP growth.[3] In our second robustness check, we show that our results are robust to: a) the inclusion of landlocked countries, originally excluded initially from the analysis; b) extending the banking sample from 2013 to 2018, by combining two different banking datasets. Our third check verifies the robustness of our findings to country, bank and firm observables and various interactions of fixed effects. Finally, we show that alternative clustering of standard errors does not modify our key findings.

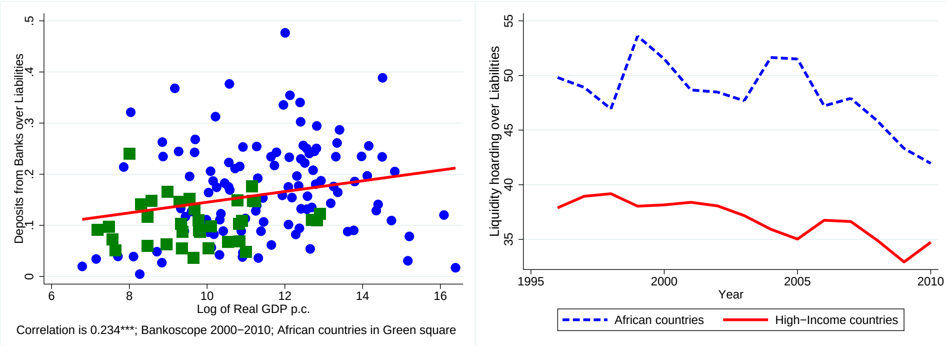
The paper contributes to two literatures. First, this is the first paper to study how financial technology affects banks and their liquidity management function, going beyond the competition-enhancing effects of fintech (Goldstein et al. (2019)).[4] The closest papers on this topic focuses on payment systems. Benetton et al. (2019) show that while cryptomining improves the local economic environment, its "mining" component increases electricity prices and crowds out other economic activities. Higgins (2019) exploits a natural experiment generating an exogenous increase in the adoption of debit cards in Mexico, which created spillovers on other technologies and sizeable consumer gains. Two innovative papers analyze the effect of submarine cables on finance and the local economy. Eichengreen et al. (2016) study the effect

[2]The result on loan maturities is particularly important and in line with a liquidity story: as bank face lower costs of interbank transactions, this lowers their liquidity risk, making long-term loans cheaper and hence more extensive, in line with what Choudhary and Limodio (2017) find in Pakistan.

[3]This finding offers some arguments moderating the role of demand shocks. This is especially the case considering that in the period under analysis (2000-2013), internet banking was relatively underdeveloped. At the same time, the African mobile phone banking revolution starts in the early 1990s (Suri (2017)) and grows steadily over the years, as it depends on 2G and 3G network coverage, rather than submarine cables, as clarified by Manacorda et al. (2017).

[4]Refer to Buchak et al. (2018) and Fuster et al. (2019) for fintech lending; Bartlett et al. (2018) and Tang (2019) for consumer and peer-to-peer lending; Berg et al. (2018) for credit scoring and Hertzberg et al. (2018) for screening; D'Acunto et al. (2019) and Abis (2017) for investment management.

Figure 1: Interbank Markets and Liquidity Hoarding



Notes: The left figure uses data from Bankscope on deposits from banks and total liabilities, while data on GDP per capita is extracted from the World Development Indicators published by the World Bank. Each dot represents a country, while green squares indicate banks operating in Sub-Saharan African countries. The right figure used data from the World Bank Global Financial Development Database. The blue dashed line indicates countries belonging to the Sub-Saharan region of Africa. In red, the collection of high-income countries according to the World Bank classification.

of submarine cables on the foreign exchange market, with results compatible with our findings: as submarine cables arrive, local banks respond with their forex trades. Second, Hjort and Poulsen (2019) show that that submarine cables improve the business opportunities for high-skill sectors and workers. Our research contributes to their finding by highlighting that high-speed internet can also affect liquidity markets and financial integration. This paper also contributes to a literature on liquidity markets, as we complement the theoretical literature on the importance of liquidity markets for credit supply and growth ((Townsend (1978), Bencivenga and Smith (1991), Saint-Paul (1992), Zilibotti (1994), Acemoglu and Zilibotti (1997), Guerrieri and Lorenzoni (2009)) and a growing empirical literature on liquidity risk and credit (Choudhary and Limodio (2017), Limodio and Strobbe (2017)). On the specific institution of the interbank market, three papers offer the latest insights about its functioning. Heider et al. (2015) develop a theoretical model of interbank lending, which generates equilibrium liquidity hoarding in line with our empirical findings. Allen et al. (2018) explain the heterogeneity in interbank access with the levels of trust in the stability of the country's banking sector. Finally, Craig and Ma (2018) model how intermediation arrangements emerge in the interbank market and quantify how shocks are transmitted across the network.

The rest of the paper is organized as follows. Section 2 introduces the empirical framework and presents the data. In section 3, we show the results from the empirical analysis. Section 4 presents some robustness checks. Finally, we offer some concluding remarks in section 5.

2 Empirical framework and data

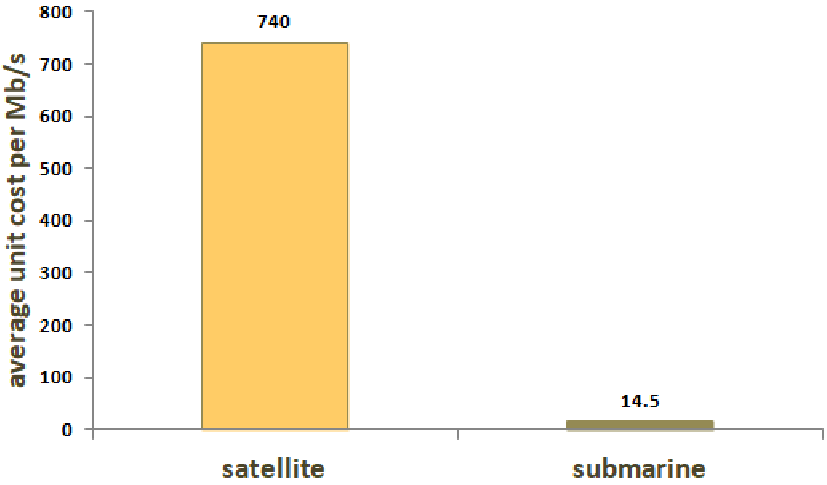
2.1 Submarine cables and banking

In 1842 Samuel Morse demonstrated the feasibility of transmitting telegraphic signals over long distances. Starting from then, submarine cables in the oceans have had a long history. The first telegraphic cable under the sea connected England and France in 1850-1851, whereas the first long-term successful transatlantic cable was laid between Newfoundland, Canada, and Ireland in 1866. The early cables consisted of copper wire insulated by gutta percha, and protected by an armoured outer casing. Despite their rapid diffusion, early submarine cables suffer from reliability and capacity problems. In the absence of repeater amplifiers, high voltages were required to transmit signals over long distances, creating distortion, limiting carrying capacity and heightening the risk of short-circuiting.

At the turn of the 19th and the 20th century, the science of transmitting higher frequencies, with the development of a practical vacuum-tube-based repeater amplifier, was established. However, commercialization was delayed by the two World Wars and the Great depression. The first modern submarine cable, TAT-1 (Transatlantic No. 1), a coaxial cable insulated using polyethylene and utilizing vacuum tubes as repeaters, was laid in 1955. In the next 25 years, coaxial cables of greater reliability and carrying capacity that operated with narrower bandwidths and utilized transistors, were developed.[5] In the 1980s, coaxial cables were replaced by modern fibre-optic cables: glass fibres conveying signals by light rather than electric current. The advantages of fibre-optic cables are several: from greater reliability, to higher capacity and faster speed of transmission. The first submarine fibre-optic cable was laid in 1986 between England and Belgium, whereas the first transatlantic cable connected France, the United Kingdom and the United States in 1988. At that time the Internet was beginning to take shape, and the development of the global fibre-optic network and the Internet proceeded simultaneously. The modern Internet would probably not have been possible without the communications opportunities offered by fibre-optic cables (Carter (2010)). Over the last 30 years more than 1 million kilometres of cables have been constructed all over the world. The path of construction has been fairly irregular. After a great burst during the period 2000-2002, in conjunction with

[5] In coaxial cables, the copper or copper-plated steel wire is surrounded by an insulating layer which is in turn enclosed by a metallic shield.

Figure 2: per Mbit/s transported



Notes: Average unit cost per Mb/s capacity based on 2008 thousands US$ (Detecon, 2013).

the dot-com bubble, the cable-laying industry contracted severely, eventually coming back to the previous growth rates following 2008 and the great financial crisis.

Nowadays, it is estimated that more than 95% of ICT data are carried on low cost modern fibre-optic submarine cables.[6] Fibre-optic technology is ubiquitous. Transmission of data through submarine cables has several advantages: it increases the reliability of connection; it increases the speed of the signal and the overall capacity; finally, it reduces transmission costs. Figure 2 shows the average unit cost per Mb/s capacity based on 2008 prices. As we can see, the price was about 740,000 US dollars for satellite transmission, compared with 14,500 US dollars for submarine fibre-optic transmission (Detecon (2013)).

Submarine cables are core infrastructures of the modern financial system. They improve some key functions of the banking system: from screening and scoring of customers, to improving the internal information processing and human resource management, which can result in a more extensive ability to interact with firms, households, banks and other players. Among the functions that are particularly affected by increasing connectivity, there is liquidity management and in particular the ability to participate in interbank market, where sizeable monetary transactions take place with intense frequencies.

Each day, the Society for Worldwide Interbank Financial Telecommunications (SWIFT) transmits more than 15 million messages over cables to over 8,300 banking organizations, se-

[6] Refer to the testimony of D. Burnett before the Senate Foreign Relations Committee on the United Nations Law of the Sea Convention, 4 October 2007, available at https://www.foreign.senate.gov/imo/media/doc/092707_100407_Transcript_The%20United%20Nations%20 Convention%20on%20the%20Law%20of%20the%20Sea.pdf

curities institutions and corporate customers in 208 countries all over the world (Burnett et al. (2013)). Referring to the submarine cables network, the Staff Director for Management of the Federal Reserve, Steve Malphrus, observed: "*when the communication networks go down, the financial sector does not grind to a halt, it snaps to a halt*", as reported by Burnett et al. (2013). The connection to the submarine cables determines whether a bank can operate in real time with a long list of counterparties on the interbank market. As a consequence, the banking network, interbank operations and the speed of transaction can vary dramatically depending on whether the bank has access to fibre technology.

The staggered arrival of submarine cables in Africa during the first decade of the 21st century, constitutes a remarkable event in understanding the evolution of the banking system in the continent. In this paper we show how internet shape banking and then narrow our analysis to the study of interbank markets. In this process, we take the arrival of submarine cables in Africa as an exogenous technological shock that positively impacts banking and credit supply. It is important to highlight that the arrival of the submarine cable in Africa was mostly due to the need to increase connectivity between America, Europe and Asia.

We consider a country in Africa that, at a certain point in time, is reached by the fibre-optic cable. Banks in that country may face various effects generated by high-speed internet: an increase in competition (due to new entrants), changes in credit demand due to improvements in business conditions and/or a sizeable reduction in the transaction costs of making interbank transactions. All of these effects are likely to take place simultaneously and be captured by an indicator of the cable arrival.

Our empirical analysis capitalizes on three main facts. First, we acknowledge that before the arrival of submarine cables, the interconnection of national banking networks in Africa was mostly based on satellites (African Development Fund (2002)). In that regard, the arrival of fibre-optic cables represents a major shock to banks, as they transition from an expensive to a much cheaper technology. Second, it is important to note that geography is a crucial factor in the arrival of submarine cables in Africa. Distance from Europe was crucial for earlier cable receivers, whereas being on the route between America, Europe and Asia is key for more recent connections. Third, we exclude issues of endogeneity stemming from the idea that submarine cables have been built with the explicit purpose to improve banking. In fact, our sample stems from 2000 to 2013, whereas Hibernia Express, which was tested in September 2015, was the first submarine cable laid for the express purpose of electronic trading in financial markets. Before that time, submarine cables have been constructed with the broader aim to accommodate general telecommunication needs, namely long-distance telegraphic communication, telephone calls, fax and internet transmission.

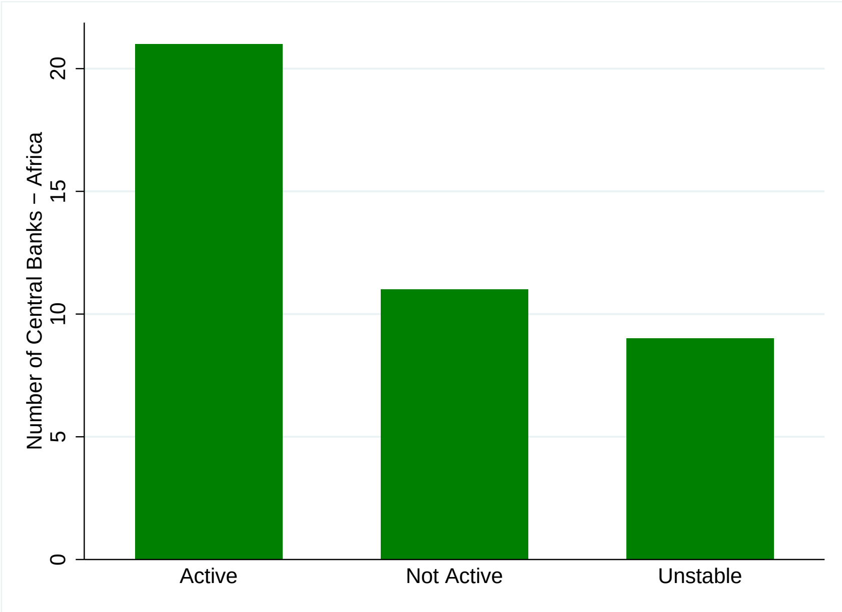
2.2 Liquidity Markets in Africa

Among the bank functions that high-speed internet can affect, we explore particularly its effect on shaping liquidity markets and the access to interbank operations.

Africa constitutes the best laboratory to explore our research question because of three reasons. First, banks in Africa experience substantial liquidity risk, due to imperfect risk sharing and high volatility of deposits. Second, African countries are characterized by a severely limited functioning of local liquidity markets, which exacerbates deposit shocks. Third, the staggered arrival of submarine cables in Africa provides the ideal setting for econometric investigation. Therefore, we think that statistical power in our analysis is quite high and that, among the reasons behind the effect of fibre-optic technology on banking, there is an important effect generated by the associated reduction in interbank transaction costs.

Banks in Africa are severely impaired in their access to international capital markets, because of local regulation or, even more importantly, because of low international reputation. At the same time, most of the central banks in Africa are either legally unable or *de facto* unwilling to provide liquidity on a predictable basis. Figure 3, below, shows data on the status of discount window facilities for all countries in Africa, as described by Choudhary and Limodio (2017), based on local or International Monetary Fund and World Bank documentation, and confirms that more than 50% of central banks are not actively engaged in these operations.

Figure 3: window facilities



Notes: Data are from local sources, the International Monetary Fund and World Bank documentation. On the y axis is the number of Central banks in Africa. On the x axis a classification of the central banks in terms of how are they active in providing discount window facilities: active, not active and unstable.

Moreover, local interbank markets are generally very small or non-existent, forcing African banks to rely on the hoarding of reserves and liquid assets to smooth liquidity shocks. Hence, a major reduction in the cost of interbank transactions, such as the one following the introduction of fibre-optic cables, can dramatically reshape the financial system and generate cascade effects on credit supply and growth.

Recent orientation of policy makers also acknowledges that lack of credit is mostly a supply problem, where liquidity risk and banks play a major role. For example, World Bank (2015) presents a survey of financial development among financial sector practitioners (bankers, central bankers, regulators, academics), from which two important messages emerge: 1) access to finance is a supply problem (75% of respondents agree); 2) domestic banks are core institutions determining how firms and households have access to finance (61% of respondents agree). Our paper aims to contribute to this evidence and to show that, improving the functioning of liquidity markets, notably through the deepening of interbank markets, generates positive effects on risk sharing, banking efficiency, credit supply and growth.

2.3 Data

In this section, we describe the datasets employed and present summary statistics.

In the first part of our analysis, we focus on the effects of fibre-optic submarine cables on banking. The main data source is Bankscope from Bureau van Dijk. Bankscope contains financials and finance reports, as well as ownership and subsidiary information for about 30,000 public and private banks across the globe. We have completed data from Bankscope database until 2013, its last year of operations. We use Bankscope to construct our main dependent variables and some of the control variables that we use in the robustness section. In the specific, we create indicators for interbank activity, proxies for the share of liquid assets over deposits and short-term funding, and an indicator of private-sector loans.

We then integrate bank-level data with hand collected country-level data for submarine cables. Our main source is TeleGeography maps, a Telecommunications market research and consulting firm providing data on the telecom industry since 1989. TeleGeography provides general information about the fibre cables: their names, their total length, the owners (generally a consortium of public and private companies), the list of landing points (country and town of landing), and the year from which the cables are ready to serve (RTS). Moreover, it supplies the shapefiles of the worldwide submarine cable network, that are useful instruments to generate customized maps.

We combine our main dataset (Bankscope integrated with information about the submarine cables) with two ancillary sources from the World Bank: the World Bank Global Financial Development Database and the World Bank Worldwide Governance Indicators. The WB GFDD is an extensive dataset of financial system characteristics for 214 economies, capturing various aspects of financial institutions and markets. The WB WGI contains aggregate and individual governance indicators for over 200 countries and territories over the period 1996-2018, for six dimensions of governance. We use both the datasets to extract control variables at the country-level.

Finally, we update our base dataset for robustness purposes. We use the new BankFocus database by Bureau van Dijk to update Bankscope data. BankFocus is meant to fulfil the same goal of Bankscope. In fact, most of its variables correspond to the ones contained by its forefather. However, it is still subject to limited data availability and historical coverage is severely restricted. Notwithstanding these facts, we use BankFocus to fill some of the missing that are in Bankscope and, most importantly, to enlarge our dataset up to 2018.

In the second part of our analysis, we focus on the real effects related to the arrival of fibre-optic submarine cables. In that regard, we exploit the same dataset used for the banking analysis, integrated with data on firm's characteristics, business activity, and funding, coming from the World Bank Enterprise Survey (ES). The WB ES offers an expansive array of economic data for 144,000 firms in 142 countries gathered through different surveys that spread from 2002 to 2018. For the purpose of this paper, we focus on surveys conducted in African coastal countries, during the period 2006-2018.

Our final dataset includes information on 702 banks, in 102 cities, for 52 countries in Africa, during the period 2000-2013.[7] However, the main analysis is carried out on countries that are on the coast, excluding those that are landlocked. We decide to focus primarily on coastal countries because for those that are landlocked is not clear whether (and when) terrestrial connections have made available the access to the fibre-optic technology.[8] Therefore, our final sample considers 551 banks, in 85 cities, for 37 countries. As concern firms information, our dataset includes data for 28,171 firms in 29 countries. Countries are all coastal and the amount of firms participating into the surveys per country is well-spread across countries.[9]

For each country, we use the arrival of the first fibre-optic submarine cable to proxy for a positive technological shock to the adoption of financial technology and banking. In a subsequent analysis, we narrow down the scope of our investigation to the interbank market, interpreting high-speed internet as a shock that reduces transaction costs for interbank deals. We assume that once the cable lands in a country, banks in the sample are automatically connected. This assumption is motivated by two facts. First, banks in our sample are typically located in capital cities, which are usually the places receiving high-speed internet first. Second, among companies, banks are likely to be early-adopters since new technologies are generally associated with sizeable profits.

In Africa, fibre-optic submarine cables have arrived staggered in time for different countries.[10] The time of arrival spans from 2000 to 2013, corresponding to the entire observation period that we cover with our data. Figure 4 shows the dynamics of the cables arrival.

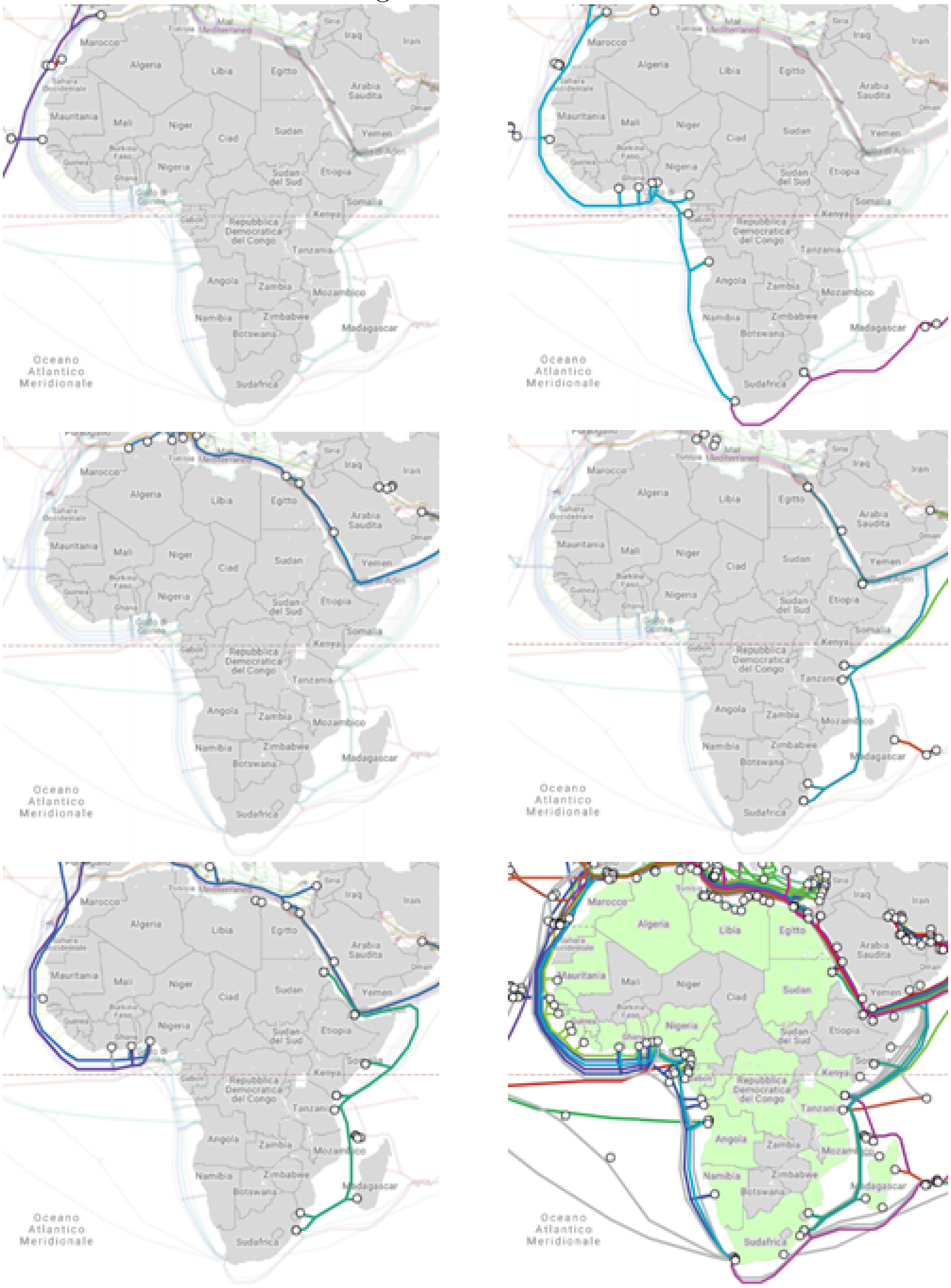
[7] The extended version of the sample, including data until 2018, is only used in one of the robustness checks.

[8] We include landlocked countries in one of the robustness checks and we consider them as non-treated.

[9] There are only a few exceptions as Egypt-2013 and Nigeria-2014. Together, those two surveys account for 20% of our observations.

[10] Appendix A offers a Table in which, for all the countries in Africa, we have the name of the first submarine cable landed, and the month and year from which that cable was ready to service.

Figure 4:   in Africa



Notes: Submarine fiber-optic cables in Africa. Top panel on the left: cables ready to serve in 2000. Top panel on the right: cables ready to serve in 2002. Middle panel on the left: cables ready to serve in 2005. Middle panel on the right: cables ready to serve in 2009. Bottom panel on the left: cables ready to serve in 2010. Bottom panel on the right: cables ready to serve in 2012 and sample of coastal countries (in light green). Data are from Telegeography maps and they are available online.

In this paper, we exploit the staggered arrival of submarine cables to identify the effect of high-speed internet on banking and then, on the real economy.

In order to evaluate the effects of the new technology on interbank markets and credit supply, we focus on the following dependent variables: Loans to banks, Deposits from banks, and Interbank (loans to and deposits from banks), that proxy for the interbank market; Liquid

Assets/Deposits and short-term funding, that proxies for the hoarding of liquid assets; and Private loans, that proxies for credit supply.

To assess the effects of the new technology on firms credit and business activity, we define the following dependent variables: Access to finance, a dummy variable that shows how much firms consider access to finance to be an issue; Loans from banks, whether the firm has issued at least one loan with a commercial bank in the last fiscal year; Sales, the amount of total annual sales; and Loans maturity, the term, in months, of loans from banks. As a main predictor, we use a dummy, submarine, that is a binary variable for the arrival of the fibre-optic submarine cable in the country. This dummy takes value zero before the arrival of the cable and 1 from the time of the arrival on.

In some of our specifications, we also do a refinement of the previous dummy to check for bank's and country's heterogeneity. In the analysis related to the banking activity, we concentrate on submarine $\times$ weak lender, namely the interaction term between the dummy submarine and a dummy that specifies whether the bank was below the median of loans to banks before the arrival of the submarine cable. In the analysis at the firm level, instead, we look at submarine $\times$ weak interbank, where the latter represents the interaction term between the dummy submarine and a dummy that specifies whether the country was below the median of interbank transactions before the arrival of the submarine cable.

Table 1 provides summary statistics for both dependent (bank's and firm's) and independent variables. Column 1 refers to the number of observations. Columns 2 and 3 refer to mean and standard deviation. Finally, columns 4 to 6 show 50th, 5th and 95th percentiles.

Table 1: Summary Statistics

Variables	Obs.	Mean	Std. Dev.	Median	5th P.tile	95th P.tile
	Panel A - Dependent variables: banks (2000-2013)					
Loans to Banks	3,565	3.735	2.077	3.795	0.429	7.160
Deposits from Banks	2,794	2.675	2.422	2.801	-1.557	6.433
Interbank	2,793	4.430	1.956	4.518	1.332	7.692
Liquid Assets/dep. & ST	3,861	0.466	0.390	0.393	0.102	0.946
Private loans	3,845	4.861	2.086	4.773	1.647	8.240
	Panel B - Dependent variables: firms (2006-2018)					
Access to finance	25,389	0.638	0.481	1	0	1
Loans from Banks	25,222	0.211	0.408	0	0	1
Sales	24,314	16.427	2.887	16.267	12.100	21.522
Loans Maturities	1,139	3.007	1.048	3.178	1.098	4.431
	Panel C - Independent variables					
Sample of Banks:						
Submarine	3,902	0.647	0.478	1	0	1
Submarine × Weak Lender	3,867	0.247	0.431	0	0	1
Sample of Firms:						
Submarine	28,171	0.843	0.363	1	0	1
Submarine × Weak Interbank	28,171	0.253	0.435	0	0	1

Notes: This table reports the summary statistics for our main dependent and independent variables. Panel A shows statistics for the dependent variables related to banks indicators: Loans to banks (natural logarithm of loans to banks (in million of US dollars)); Deposits from banks (natural logarithm of loans to banks (in million of US dollars)); Interbank (natural logarithm of loans to banks + deposits from banks (in million of US dollars)); Liquid Assets/Deposits and ST funding (ratio between liquid assets and deposits and short-term funding); Private loans (natural logarithm of net loans (in million of US dollars)). Panel B shows statistics for the dependent variables related to firms indicators: Access to finance (dummy variable where 1 indicates easy access to finance); Loans from banks (dummy variable where 1 indicates at least one loan from a commercial bank); Sales (natural logarithm of the amount of total annual sales); Loans maturities (natural logarithm of the term, in days, of loans from banks). Panel C focuses on the main predictors. In both the analysis, on banks and firms, we have: submarine, a binary variable for the arrival of the fibre-optic submarine cable in a country. This dummy takes value zero before the arrival of the cable and 1 from the time of the arrival on. In the banking analysis, we also have: submarine × weak lender, the interaction between the dummy submarine and a dummy that specifies whether the bank was below the median of loans to banks before the arrival of the cable. Finally, with regard to the analysis on firms, we have: submarine × weak interbank, the interaction between the dummy submarine and a dummy that specifies whether the country was below the median of interbank value of transactions before the arrival of the cable.

2.4 Empirical Methodology

In this section, we present our empirical strategy.

With the aim to assess the effects of fibre-optic submarine cables (high-speed and reliable internet) on banking, credit supply and firms activity, we make use of three different methodologies. First, we present an event study that is meant to test for pre-trends and to show the dynamics of the treatment effect. Second, we use a standard two-way fixed effects regression to implement a staggered diff-in-diff design. The staggered diff-in-diff provides synthetic estimates of the average treatment effect under the assumptions of no pre-trends and constant treatment. Third, we enrich our framework with the inclusion of bank specific (or country specific, in the case of firms analysis) characteristics to check for banks-level (country-level) heterogeneities. In that case, we also include country-year fixed effects to mitigate endogeneity issues.

The next paragraphs provide a detailed description of each the above mentioned methodologies.

The first specification that we propose is a classical event study based on the year of arrival of the submarine cable. The event study allows to check for pre-trends and, in a lesser extent, to provide preliminary evidence on the dynamics of the causal effect. The empirical specification that we test is as follows:

$$Y_{ict} = \alpha_i + \beta_t + \gamma_{-A} I \{K_{ct} \leq A\} + \sum_{k=-A}^{B-1} \gamma_K I \{K_{ct} = k\} + \gamma_{B+} I \{K_{ct} \geq B\} + \varepsilon_{ict} \tag{1}$$

where: Y_{ict} represents the dependent variable, for bank i, in country c, at time t; α_i and β_t are the unit (bank) and period (year) fixed effects; K_{it} is the relative year from the activation of the cable, $K_{ct} = t - ACT_c$; $A \geq 0$ are the leads that we include in our analysis; $B \geq 0$ are the terms for specific short-run effects; γ_{-A} is the single coefficient for far leads; and γ_{B+} is the single coefficient for longer-run effects.

Since we use the event study only for banking variables, our observation window ranges from 2000 to 2013, whereas we restrict the event window to be the interval [-5;+5] from the year of arrival of the cable.[11] We assign value 1 to the dummies that are at the extremes of the event window, where $A \geq K_{ct} \geq B$ and set the year before the arrival of the submarine cable as the omitted category. All of these are standard practices in the literature. For the sake of completeness, we also implement a fully-dynamic specification where the event window perfectly coincides with the observation window (see Borusyak and Jaravel (2017)).[12] Taken

[11] We have tried with different specifications of the event window. Results are particularly stable.

[12] Results from these estimates are available from the authors upon request.

together, the partial-dynamic and the fully-dynamic specifications provide solid test to check for the presence of eventual pre-trends.

The second specification that we propose is known in the literature as the static or the canonical regression. We use this specification both in the first and in the second part of our analysis (banking and firms dependent variables). Compared to the (fully or partial) dynamic specification, it imposes no pre-trends and constant treatment effects for all k. Hence, the static regression, that we simply label staggered diff-in-diff in our setting, provides a synthetic measure of the average causal effect of fibre-optic technology on our dependent variables.

The condition of having no pre-trends has been tested through the event study, whereas the constant causal effect is taken as an assumption. The empirical specification is as follows:

$$Y_{ict} = \alpha_i + \beta_t + \gamma D_{ct} + \varepsilon_{ict} \tag{2}$$

where: Y_{ict} represents the dependent variable, for bank (firm) i, in country c, at time t; α_i and β_t are the unit (bank or firm) and period (year) fixed effects; and D_{ct} is a dummy variable that equals one after the arrival of the first submarine cable and zero before.

The third specification that we propose is a modification of the staggered diff-in-diff methodology that allows for the inclusion of units specific heterogeneities. In the first part of the analysis, we want to test the basic idea that the effects of the technology shock depend on the bank's relative decline of transaction costs. In particular, banks that had higher transaction costs before the arrival of high-speed internet are the ones most exposed to the shock. With that purpose in mind, we define an indicator of weak lender (borrower) that takes value 1 if the bank was below the median of loans to banks (deposits from banks) before the arrival of high-speed internet, and zero otherwise. We specify the latter as our "core" heterogeneity. In the second part of the analysis, when dealing with firms, we use a similar reasoning and define heterogeneities by countries. In particular, we define an indicator of weak interbank market that takes value 1 if the amount of interbank transactions in the country was below the median before the arrival of high-speed internet, and zero otherwise. Then, we implement the following empirical specification:

$$Y_{ict} = \alpha_i + \beta_t + \gamma_1 D_{ct} \times hetero_{i(c)} + \gamma_2 D_{ct} + \varepsilon_{ict} \tag{3}$$

where: Y_{ict} represents the dependent variable, for bank (firm) i, in country c, at time t; α_i and β_t are the unit (bank or firm) and period (year) fixed effects; D_{ct} is a dummy variable equal to one after the arrival of the first submarine cable; and $hetero_{i(c)}$is the bank (or country, when we look at firms) specific heterogeneity (we use the general notation *hetero* to account for different heterogeneities). Notice that the presence of the dummy D_{ct} and its interaction term with $hetero_{i(c)}$ is not coupled by the inclusion of $hetero_{i(c)}$ alone. The latter is simply due to the presence of bank (or country, in the second part of the analysis) fixed effects.

In the first part, we also strengthen our findings by modifying equation (3) with the inclusion of country-year fixed effects. This final exercise, only feasible for banking specifications, have the explicit purpose to reduce endogeneity issues coming from omitted variables, and provides robustness to our basic estimates.

3 Results

In this section we report final results from our empirical analysis.

Following the main structure of the paper, we divide the section into two subsections. In the first subsection, we focus on banking outcomes. We present estimates from the event study, the staggered diff-in-diff, and the diff-in-diff with heterogeneity, as explained in the previous section. The aim of the analysis is to assess the effects that a new technology, fibre-optic for internet transmission, has had on banking in Africa. We use bank-level data from the Bankscope database to account for more than 500 banks, in 37 (not landlocked) countries, over the period 2000-2013. In the second subsection, we focus on firms activity. Through the indicators provided by the World Bank ES, we are able to estimate the effects of submarine cables on access to finance, financial linkages, and sales, for more than 28,000 firms in Africa, during the period 2006-2018. In order to implement our analysis, we use the methodologies of staggered diff-in-diff, and diff-in-diff with heterogeneity, as described in the previous section.

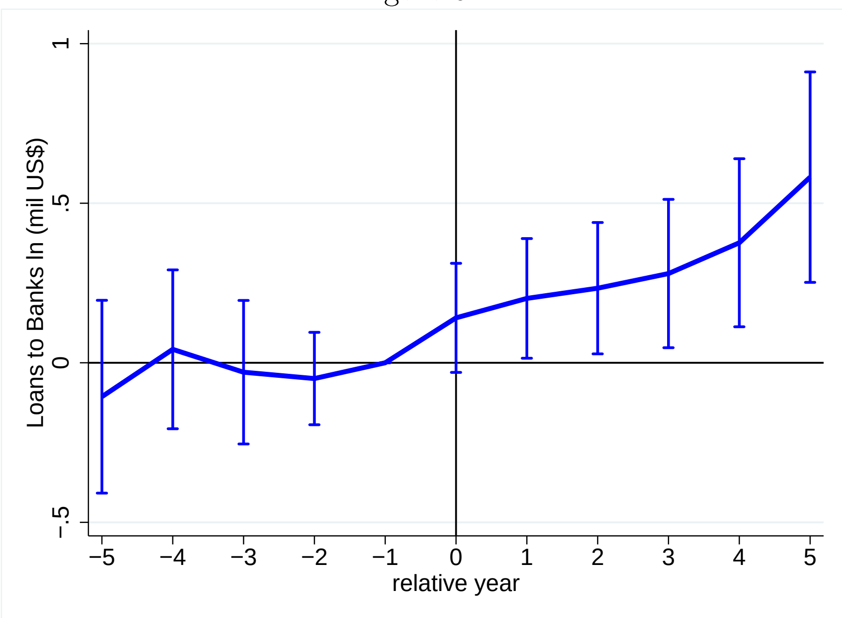
3.1 Banking

This subsection studies the effects of the arrival of fibre-optic submarine cables on banking in Africa.

The first part uses the event study methodology with the aim to rule out the presence of pre-trends and to show preliminary evidence on the treatment effect dynamics. We present our results graphically through the means of the following figures. Each figure refers to a specific dependent variable, where, as already mentioned in the data section, our dependent variables proxy for interbank activity, liquidity holding and supply of credit to the private sector. All the figures share common attributes. In particular: they have an observation window ranging from 2000 to 2013; the event window is defined over the interval [-5;+5], meaning that we consider a window of five years around the arrival of the first fibre-optic submarine cable; the x-axis reports the relative years from the arrival of the cable, whereas year 0 refers to the year of arrival; year -1 represents the omitted category, as it is standard in the literature; and, finally, the y-axis reports the dependent variable.

The first three figures refer to banks interbank activity. Figure 5 shows the relative (to the base year) dynamics of the treatment effect for bank's specific loans to other banks. As we can see, no pre-trends can be detected. Before the year of arrival of the submarine cable, point estimates are close to zero and none of them is statistically significant. On the other hand, when it comes to the year of arrival of the cable and those beyond, the pattern is clearly upward and estimates are statistically significant. We observe a jump at year zero and a gradual increase until four years after the treatment.

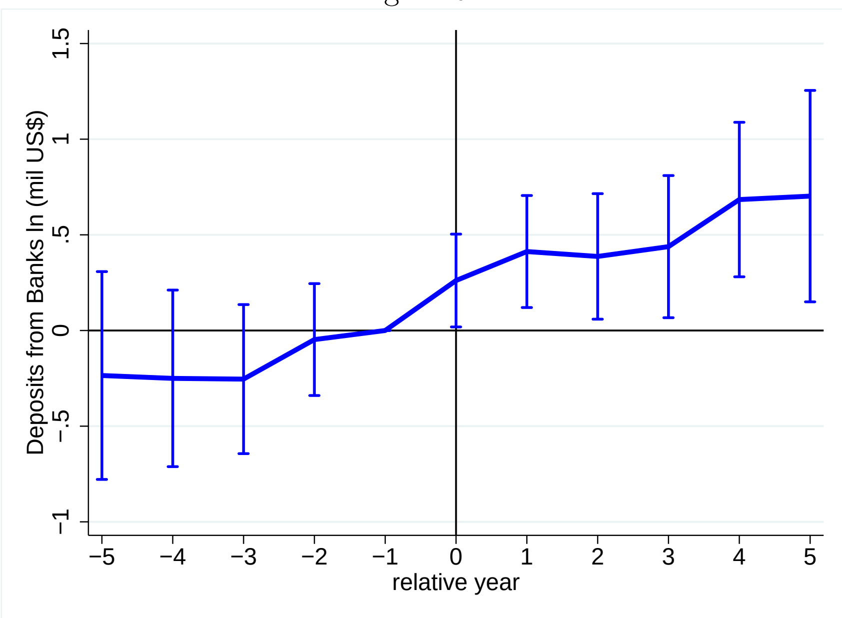
Figure 5:



Notes: Event study. On the y axis: ln(loans to banks). On the x axis: the relative time from the arrival of the first submarine fiber-optic cable. The blue line connects point estimates relative to the base year (-1). Confidence intervals are also reported.

Figure 6 replicates the same estimates but for bank's deposits from other banks. Similar to before, the pattern is almost flat previous to the arrival of the fibre-optic cable and increasing from then on. We observe a jump at year zero and a gradual increase in the next five years. In the case of deposits from banks, the magnitude of the effect is even larger than that for loans to banks. The latter finding is interesting and needs further investigation. However, prima facie it seems to suggest that the disposable of the new technology, that decreases transaction costs for interbank operations, changes the composition and the relationships within the interbank market. Particularly, small and marginal banks may benefit from lending their excess liquidity to big and central banks, whereas the latter (that mostly compose our sample) may act as liquidity hubs and final lenders to private corporates and households (an occurrence that seems extremely plausible in the context of Africa).

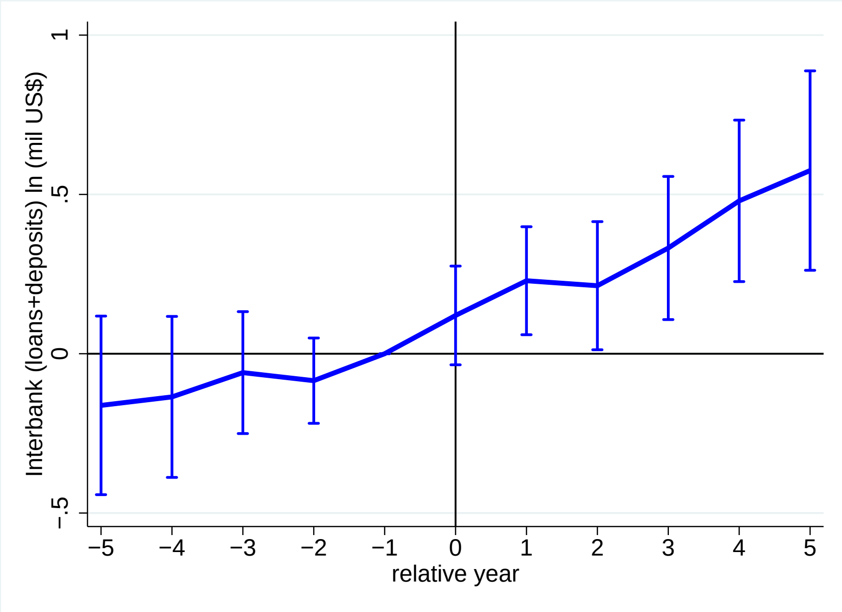
Figure 6:



Notes: Event study. On the y axis: ln(deposits from banks). On the x axis: the relative time from the arrival of the first submarine fiber-optic cable. The blue line connects point estimates relative to the base year (-1). Confidence intervals are also reported.

Figure 7 condenses information on the overall interbank activity of African banks. Our indicator of interbank transactions (loans plus deposits) shows no pre-trends and a clear trend upward starting from the year of arrival of the first submarine cable.

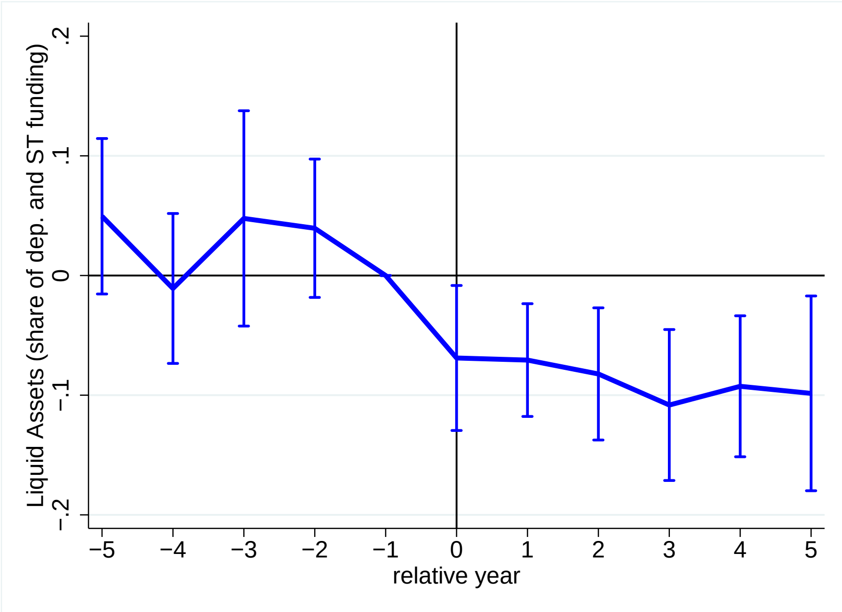
Figure 7:



Notes: Event study. On the y axis: ln(loans to banks+deposits from banks). On the x axis: the relative time from the arrival of the first submarine fiber-optic cable. The blue line connects point estimates relative to the base year (-1). Confidence intervals are also reported.

Figure 8 relates to the amount of liquid assets that the banks detain (as a share of deposits and short-term funding). Following our hypothesis, we expect no pre-trends and a significant decline in the amount of liquidity once the new internet technology is available. The idea is that, once the interbank market becomes more liquid as a consequence of the reduction in transaction costs, it offers a more efficient alternative for smoothing liquidity shocks than the hoarding of liquid assets does. The figure seems to heavily confirm our hypothesis. The pattern is almost flat before the arrival of high-speed internet (none of the estimates is statistically significant), than it sharply drops at year zero (the year of the initial treatment), finally it remains negative and stable over the next five years.

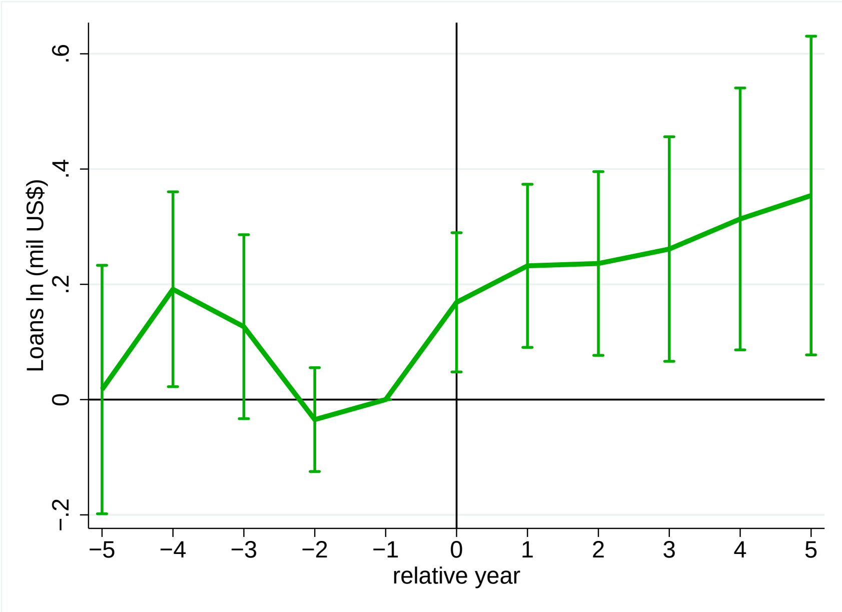
Figure 8:



Notes: Event study. On the y axis: liquidity/deposits and short-term funding. On the x axis: the relative time from the arrival of the first submarine fiber-optic cable. The blue line connects point estimates relative to the base year (-1). Confidence intervals are also reported.

Figure 9 focuses on the effects of the treatment on the supply of private credit. It does constitute the last piece of our mechanism. Fibre-optic technology reduces transaction costs in the interbank market, makes the latter more liquid, induces banks to substitute hoarding of liquid assets with (more flexible and profitable) interbank transactions, finally it leads banks to invest part of those funds in the private sector. The figure seems to confirm our hypothesis. There are no clear pre-trends (even if some of the estimates can be different from zero), whereas credit to the private sector undergoes a substantial increase after the landing of the first submarine cable.

Figure 9:



Notes: Event study. On the y axis: ln(net loans). On the x axis: the relative time from the arrival of the first submarine fiber-optic cable. The green line connects point estimates relative to the base year (-1). Confidence intervals are also reported.

To summarize, the findings from the event study suggest the following remarks. First, for none of our dependent variables there is evidence of pre-trends. Second, the effects on banking associated to the introduction of the fibre-optic technology are significant and show quite persistent dynamics. In the specific, the usage of the interbank market, in terms of loans to banks and deposits from banks, increases with the arrival of submarine cables. The hoarding of liquid assets sensibly decreases after the technological shock. Finally, credit to the private sector increases in a significant way.

The second part presents the results related to the staggered diff-in-diff design. We use the static regression in equation (2) to provide a synthetic measure of the average causal effect of the treatment on our dependent variables. The condition of having no pre-trends has been tested within the event study. Here, we make the further assumption that the the treatment effect is constant among groups and through time.

Results from the staggered diff-in-diff specification are presented in Table 2. Each column of Table 2 refers to a specific dependent variable: the three different proxies of interbank, the holding of liquid assets and, finally, private credit supply. Results from the table are in line with those presented in the event study. In particular, having access to the fibre-optic technology determines an increase in loans to banks, deposits from banks and the overall amount of interbank transactions, a decrease in the share of liquid assets over deposits and short-term funding, and an increase in private credit supply. All the estimates are statistically significant apart from the coefficient associated to loans to banks (that is almost significant at the 10%) and they are quite large in magnitude. Having access to high-speed internet, increases by 15% the amount of loans that banks in the sample provide to other banks and by 50% the amount of deposits from banks. Considering a hypothetical bank that has median values for both loans to banks (44 million of US$) and deposits from banks (16.5 million of US$), the access to the new technology causes an increase in loans to banks by almost 6.6 million of US$ and an increase in deposits from banks by 8.2 million of US$. The coefficient associated to the share of liquid assets is negative and statistically significant. Having access to the fibre causes a decrease of the share of liquid assets over deposits and short-term funding of about 10% (that is a huge number if we consider that the average share in our sample is 34%). Finally, estimates related to private credit are positive and large in magnitude, with access to fast internet causing an average increase of 17% in private credit supply.

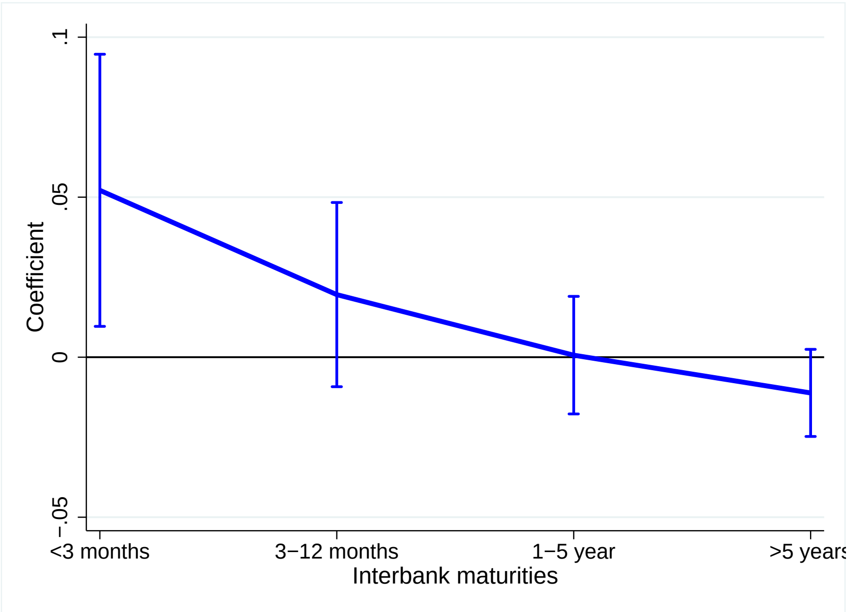
Table 2: Staggered Diff-in-Diff - Interbank, Liquidity and Loans

Variables	Liquid Assets (share DST)	Loans to Banks ln(milUS$)	Deposits from Banks ln(milUS$)	Interbank ln(milUS$)	Private loans ln(milUS$)
$submarine_{ct}$	-0.0961***	0.139	0.411***	0.202**	0.157**
	(0.0220)	(0.0894)	(0.132)	(0.0877)	(0.0687)
Obs.	3837	3536	2754	2757	3821
Bank FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Adj. R^2	0.430	0.828	0.715	0.873	0.891
M.D.V.	0.463	3.744	2.690	4.447	4.872

Notes: This table reports estimates from the staggered diff-in-diff design presented in equation (2). The dependent variables are as follows: Loans to banks (natural logarithm of loans to banks (in million of US dollars)); Deposits from banks (natural logarithm of loans to banks (in million of US dollars)); Interbank (natural logarithm of loans to banks + deposits from banks (in million of US dollars)); Liquid Assets/Deposits and ST funding (ratio between liquid assets and deposits and short-term funding); Private loans (natural logarithm of net loans (in million of US dollars)). The main predictor is submarine, a binary variable for the arrival of the first fibre-optic submarine cable in the country. This dummy takes value zero before the arrival of the cable and 1 from the time of the arrival on. Obs. refers to the number of observations; Adj.R^2 is the adjusted R^2; M.D.V. refers to the mean of the dependent variable. Fixed effects are at the bank and year level. Standard errors in parentheses, clustered at bank level. ***, ** and * indicate significance at the 1%, 5% and 10% level, respectively.

To complete our analysis, we also implement a further exercise, looking at interbank maturities. Following our hypothesis, once interbank transactions become valuable in smoothing for liquidity shocks, banks substitute hoarding of liquid assets with shorter-term interbank operations. In that regards, we expect a relative increase in short-term interbank transactions with respect to longer-term ones once the fibre-optic technology becomes available. To show that, we repeat our staggered diff-in-diff regression as in equation (2), but using as dependent variables a series of dummies identifying different interbank maturities. Results are reported in Figure 10. As we can see, coefficients associated to banks reporting short-term interbank maturities (less than three months) are positive and statistically significant, whereas those related to longer-term maturities are lower in magnitude and indistinguishable from zero. While this exercise offers valuable results, we acknowledge that the availability of interbank data along maturities is less populated than average (50% smaller sample), as a result, we would interpret these results as suggestive and intend to further investigate for higher-quality data on this.

Figure 10:



Notes: Difference in differences. On the y axis: DID coefficients and (5%,95%) confidence intervals. On the x axis: interbank maturities.

To summarize, the findings from the staggered diff-in-diff design seem to confirm those from the event study. In particular, the effects on banking associated to the introduction of the fibre-optic technology are significant and in line with our expectations. After the arrival of submarine cables, interbank markets become more liquid, the hoarding of liquid assets sensibly decreases, credit to the private sector increases and, finally, banks report relatively more short-term interbank transactions in their balance sheets.

The third part presents the results associated to the staggered diff-in-diff methodology with the inclusion of our "core" heterogeneity. The "core" heterogeneity is related to the idea that the effects of the technology shock depend on the relative decline of transaction costs. In particular, banks that had higher transaction costs before the arrival of high-speed internet are the ones that are mostly affected by the shock. To test this hypothesis, we define an indicator of "weak lender (borrower)" that takes value 1 if the bank was below the median of loans to banks (deposits from banks) before the arrival of fast internet, and zero otherwise. Then, we interact this pre-determined variable with the dummy that identifies the presence of the fibre-optic submarine cable, D_{ct}. The empirical specification is provided in equation (3). Table 3 presents the results for the case of the "weak lender". [13] We refer to the Appendix, Tables C2 and C3, for the case of the "weak borrower".

Results strongly confirm our original hypothesis. Most of the previous findings seem to be actually driven by those banks that before the arrival of fast internet were not key players in the interbank market. Apart from the reduction in the share of liquid assets, that is common to all the banks in our sample, "weak lenders" seem to be behind the increase in loans to and deposits from banks and, even more importantly, to be the ones that actually increase the amount of lending to the private sector. As a consequence, we have suggestive evidence that the arrival of fibre-optic cables, reducing transaction costs for interbank deals, has widen interbank markets and made it possible for marginal players to become more involved in the banking network and to expand their opportunities of lending.

Table 3: Staggered Diff-in-Diff and Weak Lenders

Variables	Liquid Assets (share DST)	Loans to Banks ln(milUS$)	Deposits from Banks ln(milUS$)	Interbank ln(milUS$)	Private loans ln(milUS$)
$submarine_{ct}$	-0.0493*	-0.0807	0.0527	0.00603	-0.0401
	(0.0254)	(0.111)	(0.148)	(0.0908)	(0.0944)
$submarine$	-0.0991***	0.447***	0.772***	0.444***	0.378***
$\times$ $weak\ lender_{ict}$	(0.0339)	(0.162)	(0.221)	(0.154)	(0.121)
Obs.	3720	3514	2710	2744	3715
Bank FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Adj. R^2	0.475	0.830	0.717	0.876	0.892
M.D.V.	0.461	3.750	2.696	4.450	4.933

[13] In the Appendix, Table C1, we also propose a robustness where we define the variable of weak pre-lender differently. In particular, we focus on each single country and we define a bank to be a weak pre-lender if it was below the median value, in the country, before the arrival of high-speed internet. Results are in line to those reported here.

Notes: This table reports estimates from the staggered diff-in-diff design presented in equation (2). The dependent variables are as follows: Loans to banks (natural logarithm of loans to banks (in million of US dollars)); Deposits from banks (natural logarithm of loans to banks (in million of US dollars)); Interbank (natural logarithm of loans to banks + deposits from banks (in million of US dollars)); Liquid Assets/Deposits and ST funding (ratio between liquid assets and deposits and short-term funding); Private loans (natural logarithm of net loans (in million of US dollars)). The main predictors are: submarine, a binary variable for the arrival of the first fibre-optic submarine cable in the country. This dummy takes value zero before the arrival of the cable and 1 from the time of the arrival on; and submarine × weak lender, the interaction between the dummy submarine and a dummy that specifies whether the bank was below the median of loans to banks before the arrival of the cable. Obs. refers to the number of observations; Adj.R^2 is the adjusted R^2; M.D.V. refers to the mean of the dependent variable. Fixed effects are at the bank and year level. Standard errors in parentheses, clustered at bank level. ***, ** and * indicate significance at the 1%, 5% and 10% level, respectively.

As a final exercise, we also modify the previous specification to account for country-year fixed effects. Country-year fixed effects have the explicit purpose to reduce endogeneity issues coming from omitted variables. Results are presented in Table 4 below. As we can see, estimates remain almost unchanged, whereas standard errors further decrease.

Table 4: Staggered Diff-in-Diff, Weak Lender and Country × Year Effects

Variables	Liquid Assets (share DST)	Loans to Banks ln(milUS$)	Deposits from Banks ln(milUS$)	Interbank ln(milUS$)	Private loans ln(milUS$)
$submarine$	-0.0397	0.466***	0.727**	0.529***	0.362***
$\times$ $weak\ lender_{ict}$	(0.0322)	(0.175)	(0.298)	(0.195)	(0.131)
Obs.	3676	3467	2646	2677	3671
Bank FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Country-Year FE	Yes	Yes	Yes	Yes	Yes
Adj. R^2	0.514	0.839	0.739	0.883	0.914
M.D.V.	0.459	3.755	2.731	4.470	4.950

Notes: This table reports estimates from the staggered diff-in-diff design presented in equation (2). The dependent variables are as follows: Loans to banks (natural logarithm of loans to banks (in million of US dollars)); Deposits from banks (natural logarithm of loans to banks (in million of US dollars)); Interbank (natural logarithm of loans to banks + deposits from banks (in million of US dollars)); Liquid Assets/Deposits and ST funding (ratio between liquid assets and deposits and short-term funding); Private loans (natural logarithm of net loans (in million of US dollars)). The main predictor is submarine × weak lender, the interaction between the dummy submarine and a dummy that specifies whether the bank was below the median of loans to banks before the arrival of the cable. Obs. refers to the number of observations; Adj.R^2 is the adjusted R^2; M.D.V. refers to the mean of the dependent variable. Fixed effects are at the bank and country-year level. Standard errors in parentheses, clustered at bank level. ***, ** and * indicate significance at the 1%, 5% and 10% level, respectively.

3.2 Firms

This subsection studies the effects of the arrival of fibre-optic submarine cables on firms activity in Africa.

We use data from the World Bank Enterprise Survey and we focus on survey waves from 2006 to 2018, only considering African coastal countries. We exclude data prior to 2006 because of data harmonisation issues and the impossibility to create perfectly comparable indicators. In that regard, there is partial time discrepancy between the dataset on banks, that we have used in the first part of the analysis, and that on firms, that we use in this section.

Another difference from the first part is that here we only focus on the staggered diff-in-diff methodology and its refinement including heterogeneities at the country-level.

The first part presents the results related to the staggered diff-in-diff design. We use the static regression of equation (2) to provide a synthetic measure of the average causal effect of fibre-optic technology on firms access to finance, their ability to borrow from banks, their total annual sales, and loans maturities. The baseline assumptions are as usual: no pre-trends and constant treatment effect among groups and through time.

Results from the staggered diff-in-diff specification are presented in Table 5. Each column refers to a specific dependent variable: access to finance, a dummy variable that indicates whether managers in the firm consider access to finance a minor problem; bank credit, a dummy variable that indicates whether the firm took at least one loan with a commercial bank during the last fiscal year; sales, that refers to total annual sales; and maturity, the duration, in months, of loans maturities. Results from the table are remarkable. The effects of fibre connection on firms activity are positive and significant. In particular, being connected to the fibre-optic cables is associated to an easier access to finance, to an increase in the probability that a firm gets a loan from commercial banks, to an increase in total annual sales and, finally, to an increase in loans maturities. We notice that all those effects and their combination are in line with our story, where the arrival of fibre-optic submarine cables reduces transaction costs in the interbank market, it fosters its development, it reduces the need for hoarding of reserves and liquid assets, it induces banks to reallocate funds towards private credit and, as a result, it promotes credit supply and growth.

Table 5: Staggered Diff-in-Diff - Firm's finance and sales

Variables	Access Finance (dummy)	Bank Credit (dummy)	Sales ln(USD)	Maturity ln(Months)
$submarine_{ct}$	0.150***	0.058	2.247	0.797***
	(0.040)	(0.049)	(1.523)	(0.245)
Obs.	25389	25222	24314	1139
Country FE	Yes	Yes	Yes	No
Year FE	Yes	Yes	Yes	Yes
Adj. R^2	0.0951	0.127	0.347	0.112
M.D.V.	0.638	0.211	16.43	3.008

Notes: This table reports estimates from the staggered diff-in-diff design presented in equation (2). The dependent variables are as follows: Access to finance (dummy variable where 1 indicates easy access to finance); Loans from banks (dummy variable where 1 indicates at least one loan from a commercial bank); Sales (natural logarithm of the amount of total annual sales); Loans maturity (natural logarithm of the term, in months, of loans from banks). The main predictor is submarine, a binary variable for the arrival of the first fibre-optic submarine cable in the country. This dummy takes value zero before the arrival of the cable and 1 from the time of the arrival on. Obs. refers to the number of observations; Adj.R^2 is the adjusted R^2; M.D.V. refers to the mean of the dependent variable. Fixed effects are at the country and year level. Standard errors in parentheses, clustered at country level. ***, ** and * indicate significance at the 1%, 5% and 10% level, respectively.

The second part presents the results associated to the staggered diff-in-diff design with the inclusion of heterogeneity at the country-level. Similarly to the case of banks, here we want to test the hypothesis that real effects associated to the arrival of high-speed internet are most pronounced in countries where the interbank market was relatively underdeveloped before the arrival of the cable. The idea is that countries the had underdeveloped interbank systems might benefit more from the technological shock and might experience the highest growth in terms of credit supply and firms investments. To test this hypothesis, we define an indicator of weak interbank market that takes value 1 if the amount of interbank transactions in the country was below the median before the arrival of high-speed internet, and zero otherwise. Then, we interact this pre-determined variable with the dummy that identifies the presence of the fibre-optic submarine cable, D_{ct}. The empirical specification is provided in equation (3) and Table 6 presents the empirical results.

Results provide support to our hypothesis. The effect of submarine cables on corporate finance, sales and maturities is especially relevant for firms in locations where the interbank market was not particularly developed prior to the arrival of fast internet.

Table 6: Staggered Diff-in-Diff, "weak interbank" - Firm's finance and sales

Variables	Access Finance (dummy)	Bank Credit (dummy)	Sales ln(USD)	Maturity ln(Months)
$submarine_{ct}$	0.043	-0.001	0.185	0.587**
	(0.061)	(0.047)	(1.108)	(0.214)
$submarine$	0.160**	0.097**	3.158**	0.418*
$\times$ $weak\ intb_{ct}$	(0.065)	(0.035)	(1.173)	(0.238)
Obs.	25389	25222	24314	1139
Country FE	Yes	Yes	Yes	No
Year FE	Yes	Yes	Yes	Yes
Adj. R^2	0.0965	0.127	0.362	0.127
M.D.V.	0.638	0.211	16.43	3.008

Notes: This table reports estimates from the staggered diff-in-diff design presented in equation (2). The dependent variables are as follows: Access to finance (dummy variable where 1 indicates easy access to finance); Loans from banks (dummy variable where 1 indicates at least one loan from a commercial bank); Sales (natural logarithm of the amount of total annual sales); Loans maturity (natural logarithm of the term, in months, of loans from banks). The main predictors are: submarine, a binary variable for the arrival of the first fibre-optic submarine cable in the country. This dummy takes value zero before the arrival of the cable and 1 from the time of the arrival on; and submarine $\times$ weak interbank, the interaction between the dummy submarine and a dummy that specifies whether the country was below the median interbank activity before the arrival of the cable. Obs. refers to the number of observations; Adj.R^2 is the adjusted R^2; M.D.V. refers to the mean of the dependent variable. Fixed effects are at the country and year level. Standard errors in parentheses, clustered at country level. ***, ** and * indicate significance at the 1%, 5% and 10% level, respectively.

4 Robustness

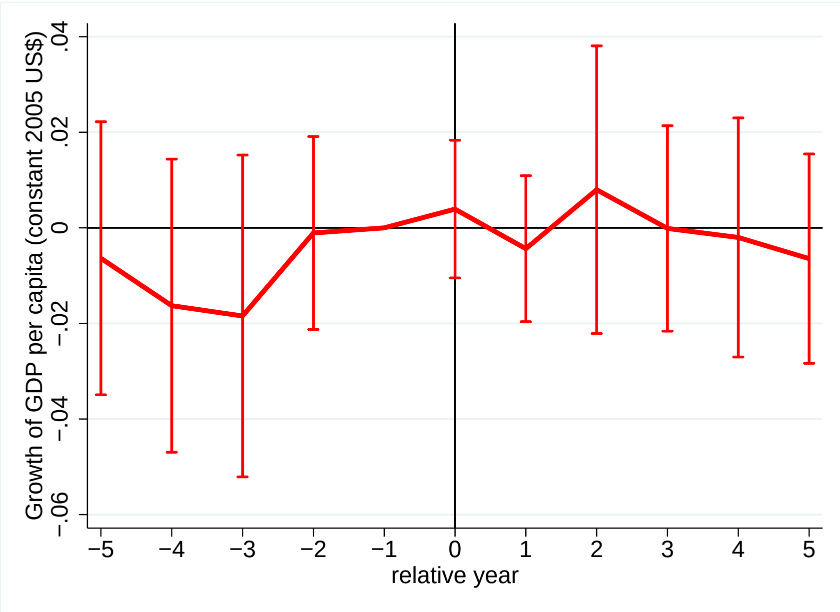
In this section, we provide robustness checks that aim to strengthen our main analysis. As usual, we divide the section into two subsections. The first relates to estimates from the banks analysis. The second relates to firms.

4.1 Banking

All the robustness that we provide in this section, apart from the first and the second, apply to the diff-in-diff specification as defined by equation (2).

First, we repeat our event study using the growth of GDP per capita as the dependent variable. We do the latter to provide preliminary evidence against the alternative story that the arrival of fibre-optic submarine cables affects banking activity through credit demand (rather than credit supply). The specification of the event study is the same as in the main analysis. The observation window ranges from 2000 to 2013, whereas we restrict the event window to be the interval [-5;+5] from the year of arrival of the cable. Results are reported in Figure 11. Importantly, from the figure we do not observe neither pre-trends nor effects at (and after) the arrival of the submarine cable. The path of GDP per capita growth is almost flat. Even if not conclusive, the latter provides first evidence on the fact that demand factors are unlikely to be the main drivers of our findings.

Figure 11: of GDP per capita



Notes: Event study. On the y axis: growth rate of GDP per capita. On the x axis: the relative time from the arrival of the first submarine fiber-optic cable. The red line connects point estimates relative to the base year (-1). Confidence intervals are also reported.

Second, we repeat our event study restricting the event window to be the interval [-3;+3] from the year of arrival of the cable. Results are reported in Figure B1. As we can see, our main findings remain stables. None of the dependent variables shows pre-trends. Indicators of interbank, loans to banks and deposits from banks, increases with the arrival of submarine cables. The hoarding of liquid assets decreases after the technological shock. Finally, credit to the private sector increases in a significant way.

Third, our analysis primarily focuses on the restricted sample of African coastal countries. The exclusion of landlocked countries is motivated by the difficulty to identify terrestrial backbones and the possibility that landlocked countries are actually importing fibre-optic technology from coastal neighbourhood. As a robustness check, we enrich our analysis with the inclusion of landlocked countries, with the strong assumption that this group is never treated. Results are reported in Table D1 of the Appendix. As we can see, estimates preserve the expected signs and remain statistically significant. We observe a slight reduction in the magnitude of the effects but, overall, findings support the intuitions presented in the main analysis. The inclusion of landlocked countries is important for two reasons. First, it enlarges our sample and provides a pure control group to include in the staggered diff-in-diff analysis. Second, following Borusyak and Jaravel (2017), it alleviates the problem of negative weights that can, potentially, bias our estimates.

Fourth, we directly control for negative weights. The staggered diff-in-diff analysis differs from the traditional (two periods-two groups) one because multiple treatment happen during the time period. In econometric terms, defining a group by the timing of its treatment, each of them acts both as a treated and a control group depending on the interval under consideration. The average treatment effect, the final outcome of the two-way fixed effects regression, is thus a weighted average of the different DID estimates obtained considering each interval separately. A recent strand of the literature has criticized this methodology, providing theoretical and empirical arguments on the fact that heterogeneous treatment effects can bias the analysis and lead to erroneous interpretations of the coefficients. In particular, when already-treated units act as controls, changes in their treatment effects over time get subtracted from the DID estimate, making it possible the occurrence of negative weights. We test for the presence of negative weights and show that they indeed represent a negligible issue in our setting. [14]

Fifth, we enlarge our dataset to span for a longer time period. We merge data from Bankscope with those provided by the new BankFocus database by Bureau Van Dijk. In that way, our sample spans from 2000 to 2018. We replicate our estimates and find that coefficients are identical in sign and larger in magnitude than those obtained in the main analysis (statistical significance is preserved). Results are reported in Table D2 of the Appendix.

Sixth, in order to deal with the high presence of missing values in our dataset, we create a restricted subsample where we have no missing for each of the dependent variables. This subsample is composed by 214 banks from 28 different countries. Results from our estimates are reported in Table 7 below. Notwithstanding the relevant reduction in the number of observations, our results are qualitatively confirmed and quantitatively magnified, both in terms of magnitude and statistical significance.

[14] In particular, they are not correlated to the timing of the high-speed internet arrival.

Table 7: Staggered Diff-in-Diff - restricted sample, no missing

Variables	Liquid Assets (share DST)	Loans to Banks ln(milUS$)	Deposits from Banks ln(milUS$)	Interbank ln(milUS$)	Private loans ln(milUS$)
$submarine_{ct}$	-0.114***	0.291**	0.743***	0.404***	0.336***
	(0.0229)	(0.134)	(0.176)	(0.113)	(0.104)
Obs.	1415	1415	1415	1415	1415
Bank FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Adj. R^2	0.618	0.865	0.769	0.904	0.939
M.D.V.	0.376	4.205	3.046	4.732	5.631

Notes: This table reports estimates from the staggered diff-in-diff design presented in equation (2). Differently from the main estimates, here we restrict the sample to include only those observations with no missing associated to (each of) the dependent variables. The dependent variables are as follows: Loans to banks (natural logarithm of loans to banks (in million of US dollars)); Deposits from banks (natural logarithm of loans to banks (in million of US dollars)); Interbank (natural logarithm of loans to banks + deposits from banks (in million of US dollars)); Liquid Assets/Deposits and ST funding (ratio between liquid assets and deposits and short-term funding); Private loans (natural logarithm of net loans (in million of US dollars)). The main predictor is submarine, a binary variable for the arrival of the first fibre-optic submarine cable in the country. This dummy takes value zero before the arrival of the cable and 1 from the time of the arrival on. Obs. refers to the number of observations; Adj.R^2 is the adjusted R^2; M.D.V. refers to the mean of the dependent variable. Fixed effects are at the bank and year level. Standard errors in parentheses, clustered at bank level. ***, ** and * indicate significance at the 1%, 5% and 10% level, respectively.

Seventh, again to alleviate the problem of missing values, we make data imputation and fill the gaps through the mice imputation function. [15] Results from our estimates are reported in Table D3 of the Appendix. As we can see, all our main results keep unchanged.

Eight, we include country specific and bank specific control variables in our main specification. Appendix E is entirely devoted to that exercise. Table E1 shows the estimates when controls are at the country level. In particular, we include the natural logarithm of GDP per capita and the CPI rate to proxy for the economic development of the country and inflation. Results are in line with those in the main specification: coefficients preserve their sign and statistical significance. Table E2 includes a proxy for the regulatory quality of the country: rule of law from the World Bank WGI database. The latter captures perceptions of the extent to which agents have confidence in and abide by the rules of society, and in particular the quality of contract enforcement, property rights, the police, and the courts. Again, our estimates remain unchanged. Table E3 introduces bank level characteristics to control for the size of the bank, its amount of total assets and the deposits it gathers. Coefficients preserve sign and statistical significance and they are almost unaltered by the inclusion of (time-varying) bank-specific factors. Finally, Table E4 deals with the contemporaneous inclusion of all the previous

[15] We use random forest to impute the missing values.

control variables. Apart from the lost of significance and decrease in magnitude associated to the logarithm of private loans, all other estimates are confirmed.

Ninth, we replace bank fixed effects with country fixed effects, given that our treatment is at the country level. Results are reported in Table F1 of the Appendix. As we can see, country fixed effects generally reduce the significance of our estimates, without, however, altering the main message of our analysis. Proxies for the interbank market are positively related to the fibre-optic technology, whereas liquid assets are negatively related to it and private credit shows a positive coefficient.

Tenth, we test for different clustering of the errors. Results are provided in Appendix G. Table G1 shows the results when we cluster at the city level. Table G2 reports estimates when we cluster at the country level. Finally, Table G3 shows results when the cluster is at the country-year level. Clustering at more aggregated levels reduce the significance of our estimates, in particular for the coefficient associated to private loans. However, none of the different specification dramatically changes our findings.

4.2 Firms

All the robustness that we provide in this section apply to the diff-in-diff specification as defined by equation (2), and its modified version as defined by equation (3).

First, we create a restricted sample where we have no missing for each of the dependent variables. Results from our estimates are reported in Tables 8 and 9 below. Table 8 refers to the basic diff-in-diff, whereas Table 9 refers to the specification with the "weak interbank" heterogeneity. As we can see, estimates are basically unaffected by the sample restriction. The effects of fibre connection on firms activity are positive and significant. Being connected to the fibre-optic cables is associated to an easier access to finance, to an increase in the probability that a firm gets a loan from commercial banks, to an increase in total annual sales and, finally, to an increase in loans maturities.

Table 8: Staggered Diff-in-Diff - restricted sample, no missing

Variables	Access Finance (dummy)	Bank Credit (dummy)	Sales ln(USD)	Maturity ln(Months)
$submarine_{ct}$	0.159***	0.134**	2.235	0.862***
	(0.0384)	(0.0530)	(1.660)	(0.273)
Country FE	Yes	Yes	Yes	No
Year FE	Yes	Yes	Yes	Yes
Obs.	20032	20032	20032	1010
Adj. R^2	0.0929	0.124	0.360	0.118
M.D.V.	0.635	0.240	16.47	3.050

Notes: This table reports estimates from the staggered diff-in-diff design presented in equation (2). The dependent variables are as follows: Access to finance (dummy variable where 1 indicates easy access to finance); Loans from banks (dummy variable where 1 indicates at least one loan from a commercial bank); Sales (natural logarithm of the amount of total annual sales); Loans maturities (natural logarithm of the term, in months, of loans from banks). The main predictor is submarine, a binary variable for the arrival of the first fibre-optic submarine cable in the country. This dummy takes value zero before the arrival of the cable and 1 from the time of the arrival on. Obs. refers to the number of observations; Adj.R^2 is the adjusted R^2; M.D.V. refers to the mean of the dependent variable. Fixed effects are at the country and year level. Standard errors in parentheses, clustered at country level. ***, ** and * indicate significance at the 1%, 5% and 10% level, respectively.

Table 9: Staggered Diff-in-Diff, "weak interbank" - restricted sample, no missing

Variables	Access Finance (dummy)	Bank Credit (dummy)	Sales ln(USD)	Maturity ln(Months)
$submarine_{ct}$	0.0530	0.108	0.329	0.635**
	(0.0603)	(0.0653)	(1.211)	(0.240)
$submarine$	0.162**	0.0401	2.914***	0.427*
$\times$ $weak\ intb_{ct}$	(0.0670)	(0.0510)	(1.045)	(0.245)
Country FE	Yes	Yes	Yes	No
Year FE	Yes	Yes	Yes	Yes
Obs.	20032	20032	20032	1010
Adj. R^2	0.0944	0.124	0.373	0.131
M.D.V.	0.635	0.240	16.47	3.050

Notes: This table reports estimates from the staggered diff-in-diff design presented in equation (2). The dependent variables are as follows: Access to finance (dummy variable where 1 indicates easy access to finance); Loans from banks (dummy variable where 1 indicates at least one loan from a commercial bank); Sales (natural logarithm of the amount of total annual sales); Loans maturities (natural logarithm of the term, in months, of loans from banks). The main predictors are: submarine, a binary variable for the arrival of the first fibre-optic submarine cable in the country. This dummy takes value zero before the arrival of the cable and 1 from the time of the arrival on; and submarine × weak interbank, the interaction between the dummy submarine and a dummy that specifies whether the country was below the median interbank activity before the arrival of the cable. Obs. refers to the number of observations; Adj.R^2 is the adjusted R^2; M.D.V. refers to the mean of the dependent variable. Fixed effects are at the country and year level. Standard errors in parentheses, clustered at country level. ***, ** and * indicate significance at the 1%, 5% and 10% level, respectively.

Second, we include country specific control variables in our main specification. We use the natural logarithm of GDP per capita to proxy for the economic development of the country, and the CPI rate to proxy for inflation. Tables H1 and H2 of the Appendix report the results.Estimates are in line with those presented in the main specification: coefficients preserve their sign and, at least for the interaction term, their statistical significance.

Third, we cluster the errors by survey rather than by country. Results are provided in Tables H3 and H4 of the Appendix. As we can see, estimates remain unchanged and the coefficients preserve their statistical significance.

Fourth, and finally, we make a control exercise regressing firms inputs (rather than outputs) on our cables related predictors. We define three variables for inputs: workforce, as the number of full-time employees in the firm; electricity, as the total annual cost of electricity; and raw materials, as the total annual cost of raw material. We presents estimates from our regressions in Tables H5 and H6 of the Appendix. Results are in line with the findings on firms outputs. The arrival of high-speed internet through fibre-optic submarine cables is associated both with an increase in the use of workforce, and a combined increase of the other factors of production (in this case, electricity and raw materials).

5 Conclusion

In this research, we offer empirical evidence on the impact of high-speed internet on the adoption of financial technology and banking in Africa. To address this question, we assemble a comprehensive dataset on African banks and firms. Hence, we follow 551 banks, 28,171 firms and combine this information with the staggered arrival of fibre-optic submarine cables in Africa. This quasi-experimental design is particularly valuable since African countries were connected primarily because of an increase in the connectivity between America, Europe and Asia. We offer a variety of econometric methods to explore our research question: an event study with a 5-year window around the submarine cable, a difference-in-difference specification for both banks and firms, and exploit bank and country heterogeneity. Our bank-level findings highlight that high-speed internet promoted a systematic increase in private-sector lending by banks. This result is in line with our firm-level results indicating an increase in access to finance, credit, maturities and sales as high-speed internet became available.

To understand the mechanism behind our results, we further investigate how high-speed internet affects banking. As this novel technology lowers transaction costs in the African interbank markets, high-speed internet may lead to an extensive adoption of financial technologies, like the real-time gross settlement systems (RTGS). In that way, local interbank markets may become more vibrant and liquid, with positive effects on credit supply and the real economy. The idea is that, once high-speed internet is available and the costs for interbank transactions are lower, African banks can deal with liquidity risk by receiving outside liquidity from the interbank market rather than hoarding inside liquidity in cash, reserves and liquid assets. Since interbank liquidity is generally more flexible, the decline in liquidity hoarding increases banks ability to lend to the private sector.

We offer a direct test of this mechanism in two ways. First, in our analysis at the bank-level, we define a bank to be a weak interbank user if its interbank usage (on both assets and liabilities) before the arrival of the cable was below the continent, or country, median. Hence, we verify our findings are due to this type of banks lowering their liquidity hoarding, and increase their interbank operations and lending. For this test, beyond including bank and time fixed effects, we also include country $\times$ year fixed effects, which absorb all country time-varying variation and allow to exclusively focus on the cross-sectional heterogeneity implied by the prior use of the interbank market. Second, in our analysis at the firm-level, we highlight that the effect of high-speed internet is positive, sizeable and statistically significant for firms located in countries that presented weak interbank markets prior to the arrival of the submarine cable.

Overall, we believe that these results are consistent with high-speed internet promoting financial technology adoption, liquidity and credit. In particular, this paper sheds light on two critical elements for further research. First, the adoption of innovative financial technologies can shape both the business outside the bank and its inside functioning, like liquidity management. Second, promoting the size and the speed of interbank markets in Africa can improve financial integration, risk-sharing and ultimately liquidity, credit and development.

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Online Appendix

Appendix A

Table A1: African countries and first fibre-optic submarine cable

Country	Location	Cable	RTS
Algeria	Coast	ALPAL2	jul 2002
Angola	Coast	SAT3/WASC	apr 2002
Benin	Coast	SAT3/WASC	apr 2002
Botswana	Landlocked		
Burkina Faso	Landlocked		
Burundi	Landlocked		
Cameroon	Coast	SAT3/WASC	apr 2002
Cape Verde	Coast	ATLANTIS	feb 2000
Central African Republic	Landlocked		
Chad	Landlocked		
Comoros	Coast	EASSy	jul 2010
Congo	Coast	WACS	may 2012
Cote D'Ivoire	Coast	SAT3/WASC	apr 2002
Democratic Republic Of Congo	Coast	WACS	may 2012
Djibouti	Coast	SEACOM	jul 2009
Egypt	Coast	SeaMeWe-3	sep 1999
Equatorial Guinea	Coast	ACE	dec 2012
Eritrea	Coast		
Ethiopia	Landlocked		
Gabon	Coast	SAT3/WASC	apr 2002
Gambia	Coast	ACE	dec 2012
Ghana	Coast	SAT3/WASC	apr 2002
Guinea	Coast	ACE	dec 2012
Guinea Bissau	Landlocked		
Kenya	Coast	TEAMS	jul 2009
Lesotho	Landlocked		
Liberia	Coast	ACE	dec 2012
Libya	Coast	ITALY-LIBYA	1998

Table A (continued): African countries and first fibre-optic submarine cables

Country	Location	Cable	RTS
Madagascar	Coast	EASSy	nov 2009
Malawi	Landlocked		
Mali	Landlocked		
Mauritania	Coast	ACE	dec 2012
Mauritius	Coast	SAFE	apr 2002
Morocco	Coast	SeaMeWe-3	sep 1999
Mozambique	Coast	SEACOM	jul 2009
Namibia	Coast	WACS	may 2012
Niger	Landlocked		
Nigeria	Coast	SAT3/WASC	apr 2002
Rwanda	Landlocked		
Senegal	Coast	ATLANTIS	feb 2000
Seychelles	Coast	SEAS	aug 2012
Sierra Leone	Coast	ACE	dec 2012
South Africa	Coast	SAT3/WASC	apr 2002
South Sudan	Landlocked		
Sudan	Coast	SAS-1	apr 2003
Swaziland	Landlocked		
Togo	Coast	WACS	may 2012
Tunisia	Coast	SeaMeWe-4	dec 2005
Uganda	Landlocked		
United Republic Of Tanzania	Coast	SEACOM	jul 2009
Zambia	Landlocked		
Zimbabwe	Landlocked		

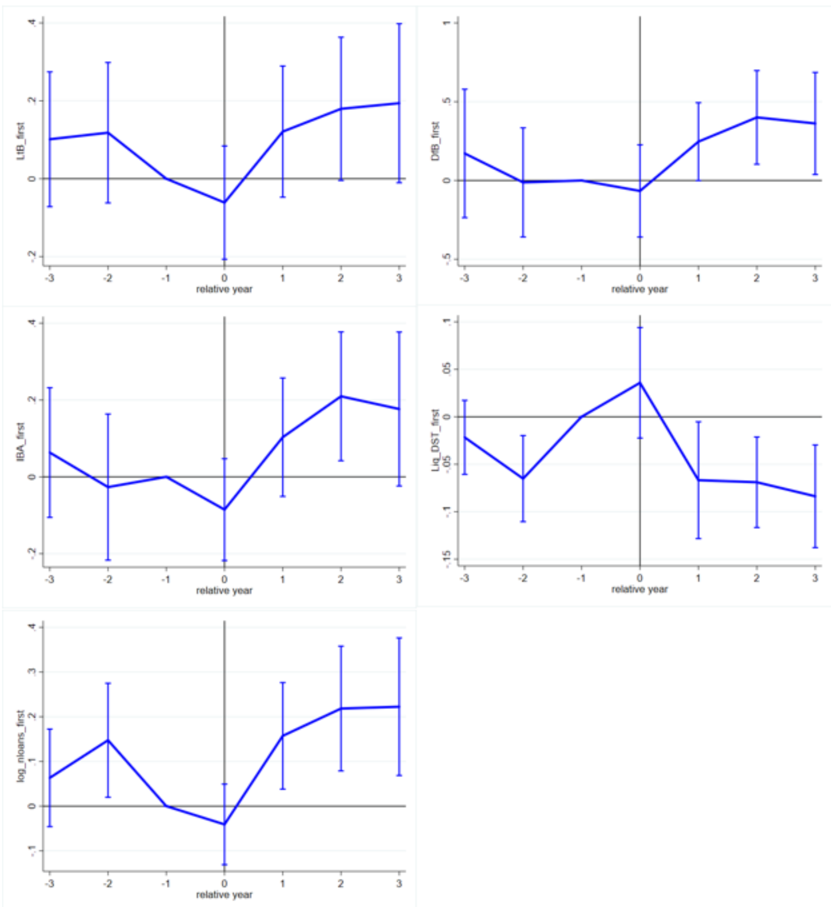
Notes: This table provides information about countries that are included in our sample. In particular, it shows the qualification of the country (coastal or landlocked), the first fibre-optic submarine cable landing on its coast (with its name), and the month and year when this cable was ready to service (RTS).

Appendix B

B1 Event study with different time window

Figure B1 reports an event study similar to the one provided in the main text. Dependent variables are: loans to banks, deposits from banks, interbank, liquid assets as a share of deposits and short-term funding, and private loans. Differently from the main specification, here we restrict the event window to be the interval [-3;+3] from the year of arrival of the cable. As we can see, our findings remain stables. None of the dependent variables shows pre-trends. Indicators of interbank, loans to banks and deposits from banks, increases with the arrival of submarine cables. The hoarding of liquid assets decreases after the technological shock. Finally, credit to the private sector increases in a significant way.

Figure B1. Event Study, 3-year window



Notes: Event study. On the y axis: dependent variables. On the x axis: the relative time from the arrival of the first submarine fiber-optic cable. The blue line connects point estimates relative to the base year (-1). Confidence intervals are also reported. This robustness differs from the main specification because of a restricted event window [-3;+3]. On the top left we find Loans to banks. On the top right, Deposits from banks. On the mid left, Interbank. On the mid right, Liquidity over deposits and ST funding. Finally, on the bottom left there are private loans.

Appendix C

C1 Alternative measure of "weak lender"

In the main text, we define a bank to be a "weak lender" if it was below the median of log loans to banks in the period before the arrival of the submarine cable. This measure, by definition, does not differentiate among banks belonging to different countries. The specification that we propose as a robustness check is meant to deal with this issue. In particular, we (re)define a bank to be a "weak lender" if it was below the median of log loans to banks before the arrival of high-speed internet, but in its own country. Then, we interact this pre-determined variable with the dummy that identifies the presence of the submarine cable. Table C1 presents the results.

Table C1: Staggered Diff-in-Diff, ”weak lender”

Variables	Liquid Assets (share DST)	Loans to Banks ln(milUS$)	Deposits from Banks ln(milUS$)	Interbank ln(milUS$)	Private loans ln(milUS$)
$submarine_{ct}$	-0.0886***	-0.0858	0.244	0.0516	0.0608
	(0.0221)	(0.103)	(0.152)	(0.0947)	(0.0855)
$submarine$	-0.0289	0.540***	0.437*	0.400**	0.218*
$\times$ $weak\ lender_{ict}$	(0.0368)	(0.166)	(0.237)	(0.164)	(0.131)
Obs.	3720	3514	2710	2744	3715
Bank FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Adj. R^2	0.473	0.831	0.715	0.875	0.891
M.D.V.	0.461	3.750	2.696	4.450	4.933

Notes: This table reports estimates from the staggered diff-in-diff design presented in equation (2). The dependent variables are as follows: Loans to banks (natural logarithm of loans to banks (in million of US dollars)); Deposits from banks (natural logarithm of loans to banks (in million of US dollars)); Interbank (natural logarithm of loans to banks + deposits from banks (in million of US dollars)); Liquid Assets/Deposits and ST funding (ratio between liquid assets and deposits and short-term funding); Private loans (natural logarithm of net loans (in million of US dollars)). The main predictors are: submarine, a binary variable for the arrival of the first fibre-optic submarine cable in the country. This dummy takes value zero before the arrival of the cable and 1 from the time of the arrival on; and submarine × weak lender, the interaction between the dummy submarine and a dummy that specifies whether the bank was below the median of deposits from banks, in the country, before the arrival of the cable. Obs. refers to the number of observations; Adj.R^2 is the adjusted R^2; M.D.V. refers to the mean of the dependent variable. Fixed effects are at the bank and year level. Standard errors in parentheses, clustered at bank level. ***, ** and * indicate significance at the 1%, 5% and 10% level, respectively.

C2 "Weak borrower"

Similarly to the case of "weak lender", that we propose in the main text, here we create an indicator of "weak borrower". We define a bank to be a "weak borrower" if it was below the median of deposits from banks before the arrival of high-speed internet. Then, we interact this pre-determined variable with the dummy that identifies the presence of the submarine cable. Table C2 presents the results.

Table C2: Staggered Diff-in-Diff, "weak borrower"

Variables	Liquid Assets (share DST)	Loans to Banks ln(milUS$)	Deposits from Banks ln(milUS$)	Interbank ln(milUS$)	Private loans ln(milUS$)
$submarine_{ct}$	-0.0246	0.00476	0.0596	-0.0170	-0.0388
	(0.0262)	(0.131)	(0.164)	(0.108)	(0.105)
$submarine$	-0.0974***	0.186	0.752***	0.397***	0.285**
$\times$ $weak\ borrower_{ict}$	(0.0340)	(0.181)	(0.217)	(0.152)	(0.124)
Obs.	3408	3202	2731	2714	3385
Bank FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Adj. R^2	0.433	0.829	0.720	0.877	0.896
M.D.V.	0.443	3.796	2.689	4.446	5.015

Notes: This table reports estimates from the staggered diff-in-diff design presented in equation (2). The dependent variables are as follows: Loans to banks (natural logarithm of loans to banks (in million of US dollars)); Deposits from banks (natural logarithm of loans to banks (in million of US dollars)); Interbank (natural logarithm of loans to banks + deposits from banks (in million of US dollars)); Liquid Assets/Deposits and ST funding (ratio between liquid assets and deposits and short-term funding); Private loans (natural logarithm of net loans (in million of US dollars)). The main predictors are: submarine, a binary variable for the arrival of the first fibre-optic submarine cable in the country. This dummy takes value zero before the arrival of the cable and 1 from the time of the arrival on; and submarine × weak borrower, the interaction between the dummy submarine and a dummy that specifies whether the bank was below the median of deposits from banks before the arrival of the cable. Obs. refers to the number of observations; Adj.R^2 is the adjusted R^2; M.D.V. refers to the mean of the dependent variable. Fixed effects are at the bank and year level. Standard errors in parentheses, clustered at bank level. ***, ** and * indicate significance at the 1%, 5% and 10% level, respectively.

C3 "Weak borrower" with country-year fixed effects

Here we analyse whether the findings from Table C2 are robust to the inclusion of country-year fixed effects. Tables C3 shows the results (it is the counterpart, for "weak borrower", of Table 4 in the main text).

Table C3: Staggered Diff-in-Diff, "weak borrower" - country-year FE

Variables	Liquid Assets (share DST)	Loans to Banks ln(milUS$)	Deposits from Banks ln(milUS$)	Interbank ln(milUS$)	Private loans ln(milUS$)
$submarine$	-0.0686**	0.102	0.726**	0.418*	0.297**
$\times$ $weak\ borrower_{ict}$	(0.0342)	(0.225)	(0.307)	(0.218)	(0.137)
Obs.	3363	3152	2668	2647	3339
Bank FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Country-Year FE	Yes	Yes	Yes	Yes	Yes
Adj. R^2	0.454	0.836	0.741	0.882	0.917
M.D.V.	0.440	3.799	2.721	4.467	5.035

Notes: This table reports estimates from the staggered diff-in-diff design presented in equation (2). Differently from the main estimates, here we included in the sample also landlocked countries. We assume landlocked countries to be never treated. The dependent variables are as follows: Loans to banks (natural logarithm of loans to banks (in million of US dollars)); Deposits from banks (natural logarithm of loans to banks (in million of US dollars)); Interbank (natural logarithm of loans to banks + deposits from banks (in million of US dollars)); Liquid Assets/Deposits and ST funding (ratio between liquid assets and deposits and short-term funding); Private loans (natural logarithm of net loans (in million of US dollars)). The main predictors is submarine × weak borrower, the interaction between the dummy submarine and a dummy that specifies whether the bank was below the median of deposits from banks before the arrival of the cable. Obs. refers to the number of observations; Adj.R^2 is the adjusted R^2; M.D.V. refers to the mean of the dependent variable. Fixed effects are at the bank and country-year level. Standard errors in parentheses, clustered at bank level. ***, ** and * indicate significance at the 1%, 5% and 10% level, respectively.

Appendix D

D1 Landlocked countries

Our analysis primarily focuses on the restricted sample of African coastal countries. Here, we enrich the analysis with the inclusion of landlocked countries, with the assumption that this group is never treated. Results are reported in Table D1.

Table D1: Staggered Diff-in-Diff - Landlocked countries

Variables	Liquid Assets (share DST)	Loans to Banks ln(milUS$)	Deposits from Banks ln(milUS$)	Interbank ln(milUS$)	Private loans ln(milUS$)
$submarine_{ct}$	-0.0808***	0.158*	0.362***	0.159*	0.109*
	(0.0199)	(0.0891)	(0.126)	(0.0859)	(0.0633)
Obs.	4983	4615	3519	3488	4978
Bank FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Adj. R^2	0.422	0.809	0.696	0.862	0.892
M.D.V.	0.458	3.565	2.535	4.274	4.684

Notes: This table reports estimates from the staggered diff-in-diff design presented in equation (2). Differently from the main estimates, here we included in the sample also landlocked countries. We assume landlocked countries to be never treated. The dependent variables are as follows: Loans to banks (natural logarithm of loans to banks (in million of US dollars)); Deposits from banks (natural logarithm of loans to banks (in million of US dollars)); Interbank (natural logarithm of loans to banks + deposits from banks (in million of US dollars)); Liquid Assets/Deposits and ST funding (ratio between liquid assets and deposits and short-term funding); Private loans (natural logarithm of net loans (in million of US dollars)). The main predictor is submarine, a binary variable for the arrival of the first fibre-optic submarine cable in the country. This dummy takes value zero before the arrival of the cable and 1 from the time of the arrival on. Obs. refers to the number of observations; Adj.R^2 is the adjusted R^2; M.D.V. refers to the mean of the dependent variable. Fixed effects are at the bank and year level. Standard errors in parentheses, clustered at bank level. ***, ** and * indicate significance at the 1%, 5% and 10% level, respectively.

D2 Updated dataset: from 2000 to 2018

We enlarge our dataset to span from 2000 to 2018. In doing it, we merge data from Bankscope with those provided by the BankFocus database from Bureau Van Dijk. Results related to our main specification are reported in Table D2.

Table D2: Staggered Diff-in-Diff - updated sample (2000-2018)

Variables	Liquid Assets (share DST)	Loans to Banks ln(milUS$)	Deposits from Banks ln(milUS$)	Interbank ln(milUS$)	Private loans ln(milUS$)
$submarine_{ct}$	-0.0874***	0.194**	0.455***	0.324***	0.181**
	(0.0197)	(0.0949)	(0.147)	(0.0968)	(0.0809)
Obs.	5389	5077	4029	4030	5379
Bank FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Adj. R^2	0.364	0.763	0.663	0.823	0.864
M.D.V.	0.444	3.820	2.860	4.565	5.104

Notes: This table reports estimates from the staggered diff-in-diff design presented in equation (2). Differently from the main estimates, here we expand our dataset using data from BankFocus. As a result, our time period ranges from 2000 to 2018. The dependent variables are as follows: Loans to banks (natural logarithm of loans to banks (in million of US dollars)); Deposits from banks (natural logarithm of loans to banks (in million of US dollars)); Interbank (natural logarithm of loans to banks + deposits from banks (in million of US dollars)); Liquid Assets/Deposits and ST funding (ratio between liquid assets and deposits and short-term funding); Private loans (natural logarithm of net loans (in million of US dollars)). The main predictor is submarine, a binary variable for the arrival of the first fibre-optic submarine cable in the country. This dummy takes value zero before the arrival of the cable and 1 from the time of the arrival on. Obs. refers to the number of observations; Adj.R^2 is the adjusted R^2; M.D.V. refers to the mean of the dependent variable. Fixed effects are at the bank and year level. Standard errors in parentheses, clustered at bank level. ***, ** and * indicate significance at the 1%, 5% and 10% level, respectively.

D3 Imputed sample

We make data imputation to alleviate the issue of missing values. To fill the gaps in our dependent variables, we use the mice imputation function with random forest. Results from our estimates are reported in Table D3.

Table D3: Staggered Diff-in-Diff - imputed sample, fill the missing

Variables	Liquid Assets (share DST)	Loans to Banks ln(milUS$)	Deposits from Banks ln(milUS$)	Interbank ln(milUS$)	Private loans ln(milUS$)
$submarine_{ct}$	-0.110***	0.135	0.330**	0.179**	0.149**
	(0.0263)	(0.0868)	(0.128)	(0.0762)	(0.0682)
Obs.	3879	3832	3442	3856	3860
Bank FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Adj. R^2	0.422	0.811	0.637	0.826	0.881
M.D.V.	0.475	3.699	2.511	4.154	4.857

Notes: This table reports estimates from the staggered diff-in-diff design presented in equation (2). Differently from the main estimates, here we fill the missing of dependent variables in the sample using data imputation methodologies. The dependent variables are as follows: Loans to banks (natural logarithm of loans to banks (in million of US dollars)); Deposits from banks (natural logarithm of loans to banks (in million of US dollars)); Interbank (natural logarithm of loans to banks + deposits from banks (in million of US dollars)); Liquid Assets/Deposits and ST funding (ratio between liquid assets and deposits and short-term funding); Private loans (natural logarithm of net loans (in million of US dollars)). The main predictor is submarine, a binary variable for the arrival of the first fibre-optic submarine cable in the country. This dummy takes value zero before the arrival of the cable and 1 from the time of the arrival on. Obs. refers to the number of observations; Adj.R^2 is the adjusted R^2; M.D.V. refers to the mean of the dependent variable. Fixed effects are at the bank and year level. Standard errors in parentheses, clustered at bank level. ***, ** and * indicate significance at the 1%, 5% and 10% level, respectively.

Appendix E

This appendix contains four tables in which we sequentially include control variables at the country and at the bank-level.

E1 Country specific controls

Table E1 shows the estimates when controls are at the country level. In particular, we include the natural logarithm of GDP per capita and the CPI rate to proxy for the economic development of the country and inflation.

Table E1: Staggered Diff-in-Diff - country controls

Variables	Liquid Assets (share DST)	Loans to Banks ln(milUS$)	Deposits from Banks ln(milUS$)	Interbank ln(milUS$)	Private loans ln(milUS$)
$submarine_{ct}$	-0.0820***	0.130	0.399***	0.186**	0.113*
	(0.0213)	(0.0897)	(0.132)	(0.0871)	(0.0675)
Controls:					
Country indicators	Yes	Yes	Yes	Yes	Yes
Regulatory quality	No	No	No	No	No
Bank indicators	No	No	No	No	No
Obs.	3827	3525	2746	2749	3810
Bank FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Adj. R^2	0.432	0.828	0.718	0.874	0.896
M.D.V.	0.462	3.740	2.688	4.444	4.873

Notes: This table reports estimates from the staggered diff-in-diff design presented in equation (2). The dependent variables are as follows: Loans to banks (natural logarithm of loans to banks (in million of US dollars)); Deposits from banks (natural logarithm of loans to banks (in million of US dollars)); Interbank (natural logarithm of loans to banks + deposits from banks (in million of US dollars)); Liquid Assets/Deposits and ST funding (ratio between liquid assets and deposits and short-term funding); Private loans (natural logarithm of net loans (in million of US dollars)). The main predictor is submarine, a binary variable for the arrival of the first fibre-optic submarine cable in the country. This dummy takes value zero before the arrival of the cable and 1 from the time of the arrival on. In this specification, we also include other covariates. Here we control for country level variables: natural logarithm of GDP per capita and CPI rate. Obs. refers to the number of observations; Adj.R^2 is the adjusted R^2; M.D.V. refers to the mean of the dependent variable. Fixed effects are at the bank and year level. Standard errors in parentheses, clustered at bank level. ***, ** and * indicate significance at the 1%, 5% and 10% level, respectively.

E2 Regulatory quality control

Table E2 includes a proxy for the regulatory quality of the country: rule of law from the World Bank WGI database. The latter captures perceptions of the extent to which agents have confidence in and abide by the rules of society, and in particular the quality of contract enforcement, property rights, the police, and the courts.

Table E2: Staggered Diff-in-Diff - regulatory controls

Variables	Liquid Assets (share DST)	Loans to Banks ln(milUS$)	Deposits from Banks ln(milUS$)	Interbank ln(milUS$)	Private loans ln(milUS$)
$submarine_{ct}$	-0.0994***	0.111	0.400***	0.182**	0.123*
	(0.0233)	(0.0989)	(0.134)	(0.0908)	(0.0728)
Controls:					
Country indicators	No	No	No	No	No
Regulatory quality	Yes	Yes	Yes	Yes	Yes
Bank indicators	No	No	No	No	No
Obs.	3548	3268	2569	2558	3537
Bank FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Adj. R^2	0.423	0.829	0.718	0.875	0.897
M.D.V.	0.459	3.781	2.704	4.483	4.929

Notes: This table reports estimates from the staggered diff-in-diff design presented in equation (2). The dependent variables are as follows: Loans to banks (natural logarithm of loans to banks (in million of US dollars)); Deposits from banks (natural logarithm of loans to banks (in million of US dollars)); Interbank (natural logarithm of loans to banks + deposits from banks (in million of US dollars)); Liquid Assets/Deposits and ST funding (ratio between liquid assets and deposits and short-term funding); Private loans (natural logarithm of net loans (in million of US dollars)). The main predictor is submarine, a binary variable for the arrival of the first fibre-optic submarine cable in the country. This dummy takes value zero before the arrival of the cable and 1 from the time of the arrival on. In this specification, we also include other covariates. Here we control for an indicator of regulatory quality: rule of law by the World Bank WGI. Obs. refers to the number of observations; Adj.R^2 is the adjusted R^2; M.D.V. refers to the mean of the dependent variable. Fixed effects are at the bank and year level. Standard errors in parentheses, clustered at bank level. ***, ** and * indicate significance at the 1%, 5% and 10% level, respectively.

E3 Bank specific controls

Table E3 introduces bank level characteristics to control for the size of the bank, its amount of total assets and the deposits it gathers.

Table E3: Staggered Diff-in-Diff - bank controls

Variables	Liquid Assets (share DST)	Loans to Banks ln(milUS$)	Deposits from Banks ln(milUS$)	Interbank ln(milUS$)	Private loans ln(milUS$)
$submarine_{ct}$	-0.0921***	0.168*	0.477***	0.248***	0.179***
	(0.0222)	(0.0882)	(0.126)	(0.0827)	(0.0652)
Controls:					
Country indicators	No	No	No	No	No
Regulatory quality	No	No	No	No	No
Bank indicators	Yes	Yes	Yes	Yes	Yes
Obs.	3827	3510	2746	2749	3795
Bank FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Adj. R^2	0.428	0.834	0.727	0.883	0.901
M.D.V.	0.462	3.751	2.688	4.444	4.890

Notes: This table reports estimates from the staggered diff-in-diff design presented in equation (2). The dependent variables are as follows: Loans to banks (natural logarithm of loans to banks (in million of US dollars)); Deposits from banks (natural logarithm of loans to banks (in million of US dollars)); Interbank (natural logarithm of loans to banks + deposits from banks (in million of US dollars)); Liquid Assets/Deposits and ST funding (ratio between liquid assets and deposits and short-term funding); Private loans (natural logarithm of net loans (in million of US dollars)). The main predictor is submarine, a binary variable for the arrival of the first fibre-optic submarine cable in the country. This dummy takes value zero before the arrival of the cable and 1 from the time of the arrival on. In this specification, we also include other covariates. Here we control for bank level variables: size, amount of total assets and deposits. Obs. refers to the number of observations; Adj.R^2 is the adjusted R^2; M.D.V. refers to the mean of the dependent variable. Fixed effects are at the bank and year level. Standard errors in parentheses, clustered at bank level. ***, ** and * indicate significance at the 1%, 5% and 10% level, respectively.

E4 All controls

Finally, Table E4 deals with the contemporaneous inclusion of all the previous control variables, both at the country and at the bank level.

Table E4: Staggered Diff-in-Diff - country and bank controls

Variables	Liquid Assets (share DST)	Loans to Banks ln(milUS$)	Deposits from Banks ln(milUS$)	Interbank ln(milUS$)	Private loans ln(milUS$)
$submarine_{ct}$	-0.0820***	0.130	0.431***	0.207**	0.0921
	(0.0227)	(0.0992)	(0.130)	(0.0868)	(0.0682)
Controls:					
Country indicators	Yes	Yes	Yes	Yes	Yes
Regulatory quality	Yes	Yes	Yes	Yes	Yes
Bank indicators	Yes	Yes	Yes	Yes	Yes
Obs.	3538	3244	2561	2550	3512
Bank FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Adj. R^2	0.425	0.835	0.730	0.885	0.913
M.D.V.	0.458	3.788	2.702	4.480	4.948

Notes: This table reports estimates from the staggered diff-in-diff design presented in equation (2). The dependent variables are as follows: Loans to banks (natural logarithm of loans to banks (in million of US dollars)); Deposits from banks (natural logarithm of loans to banks (in million of US dollars)); Interbank (natural logarithm of loans to banks + deposits from banks (in million of US dollars)); Liquid Assets/Deposits and ST funding (ratio between liquid assets and deposits and short-term funding); Private loans (natural logarithm of net loans (in million of US dollars)). The main predictor is submarine, a binary variable for the arrival of the first fibre-optic submarine cable in the country. This dummy takes value zero before the arrival of the cable and 1 from the time of the arrival on. In this specification, we also include other covariates. Here we account for all the control variables simultaneously. Obs. refers to the number of observations; Adj.R^2 is the adjusted R^2; M.D.V. refers to the mean of the dependent variable. Fixed effects are at the bank and year level. Standard errors in parentheses, clustered at bank level. ***, ** and * indicate significance at the 1%, 5% and 10% level, respectively.

Appendix F

F1 Country fixed effects

We replace bank fixed effects with country fixed effects, given that our treatment is at the country level. Results are reported in Table F1.

Table F1: Staggered Diff-in-Diff - country FE

Variables	Liquid Assets (share DST)	Loans to Banks ln(milUS$)	Deposits from Banks ln(milUS$)	Interbank ln(milUS$)	Private loans ln(milUS$)
$submarine_{ct}$	-0.0965***	0.195*	0.353**	0.166	0.198**
	(0.0226)	(0.0999)	(0.147)	(0.106)	(0.0901)
Obs.	3861	3565	2794	2793	3845
Country FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Adj. R^2	0.166	0.392	0.324	0.448	0.449
M.D.V.	0.466	3.735	2.675	4.430	4.861

Notes: This table reports estimates from the staggered diff-in-diff design presented in equation (2). The dependent variables are as follows: Loans to banks (natural logarithm of loans to banks (in million of US dollars)); Deposits from banks (natural logarithm of loans to banks (in million of US dollars)); Interbank (natural logarithm of loans to banks + deposits from banks (in million of US dollars)); Liquid Assets/Deposits and ST funding (ratio between liquid assets and deposits and short-term funding); Private loans (natural logarithm of net loans (in million of US dollars)). The main predictor is submarine, a binary variable for the arrival of the first fibre-optic submarine cable in the country. This dummy takes value zero before the arrival of the cable and 1 from the time of the arrival on. Obs. refers to the number of observations; Adj.R^2 is the adjusted R^2; M.D.V. refers to the mean of the dependent variable. Fixed effects are at the country and year level. Standard errors in parentheses, clustered at bank level. ***, ** and * indicate significance at the 1%, 5% and 10% level, respectively.

Appendix G

Appendix G provides three different tables where, differently from the main specification, we cluster standard errors by: city, country, and country-year.

G1 Clusters city

Table G1 shows the results when we cluster at the city level.

Table G1: Staggered Diff-in-Diff - cluster city

Variables	Liquid Assets (share DST)	Loans to Banks ln(milUS$)	Deposits from Banks ln(milUS$)	Interbank ln(milUS$)	Private loans ln(milUS$)
$submarine_{ct}$	-0.0966***	0.135	0.413**	0.197*	0.147
	(0.0311)	(0.109)	(0.189)	(0.115)	(0.129)
Obs.	3831	3530	2748	2751	3813
Bank FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Adj. R^2	0.430	0.829	0.715	0.874	0.892
M.D.V.	0.463	3.747	2.692	4.450	4.877

Notes: This table reports estimates from the staggered diff-in-diff design presented in equation (2). The dependent variables are as follows: Loans to banks (natural logarithm of loans to banks (in million of US dollars)); Deposits from banks (natural logarithm of loans to banks (in million of US dollars)); Interbank (natural logarithm of loans to banks + deposits from banks (in million of US dollars)); Liquid Assets/Deposits and ST funding (ratio between liquid assets and deposits and short-term funding); Private loans (natural logarithm of net loans (in million of US dollars)). The main predictor is submarine, a binary variable for the arrival of the first fibre-optic submarine cable in the country. This dummy takes value zero before the arrival of the cable and 1 from the time of the arrival on. Obs. refers to the number of observations; Adj.R^2 is the adjusted R^2; M.D.V. refers to the mean of the dependent variable. Fixed effects are at the bank and year level. Standard errors in parentheses, clustered at city level. ***, ** and * indicate significance at the 1%, 5% and 10% level, respectively.

G2 Clusters country

Table G2 reports estimates when we cluster at the country level.

Table G2: Staggered Diff-in-Diff - cluster country

Variables	Liquid Assets (share DST)	Loans to Banks ln(milUS$)	Deposits from Banks ln(milUS$)	Interbank ln(milUS$)	Private loans ln(milUS$)
$submarine_{ct}$	-0.0961***	0.139	0.411**	0.202	0.157
	(0.0336)	(0.115)	(0.197)	(0.121)	(0.140)
Obs.	3837	3536	2754	2757	3821
Bank FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Adj. R^2	0.430	0.828	0.715	0.873	0.891
M.D.V.	0.463	3.744	2.690	4.447	4.872

Notes: This table reports estimates from the staggered diff-in-diff design presented in equation (2). The dependent variables are as follows: Loans to banks (natural logarithm of loans to banks (in million of US dollars)); Deposits from banks (natural logarithm of loans to banks (in million of US dollars)); Interbank (natural logarithm of loans to banks + deposits from banks (in million of US dollars)); Liquid Assets/Deposits and ST funding (ratio between liquid assets and deposits and short-term funding); Private loans (natural logarithm of net loans (in million of US dollars)). The main predictor is submarine, a binary variable for the arrival of the first fibre-optic submarine cable in the country. This dummy takes value zero before the arrival of the cable and 1 from the time of the arrival on. Obs. refers to the number of observations; Adj.R^2 is the adjusted R^2; M.D.V. refers to the mean of the dependent variable. Fixed effects are at the bank and year level. Standard errors in parentheses, clustered at country level. ***, ** and * indicate significance at the 1%, 5% and 10% level, respectively.

G3 Clusters country-year

Finally, Table G3 shows results when the cluster is at the country-year level.

Table G3: Staggered Diff-in-Diff - cluster country-year

Variables	Liquid Assets (share DST)	Loans to Banks ln(milUS$)	Deposits from Banks ln(milUS$)	Interbank ln(milUS$)	Private loans ln(milUS$)
$submarine_{ct}$	-0.0961***	0.139*	0.411***	0.202***	0.157*
	(0.0236)	(0.0744)	(0.124)	(0.0734)	(0.0810)
Obs.	3837	3536	2754	2757	3821
Bank FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Adj. R^2	0.430	0.828	0.715	0.873	0.891
M.D.V.	0.463	3.744	2.690	4.447	4.872

Notes: This table reports estimates from the staggered diff-in-diff design presented in equation (2). The dependent variables are as follows: Loans to banks (natural logarithm of loans to banks (in million of US dollars)); Deposits from banks (natural logarithm of loans to banks (in million of US dollars)); Interbank (natural logarithm of loans to banks + deposits from banks (in million of US dollars)); Liquid Assets/Deposits and ST funding (ratio between liquid assets and deposits and short-term funding); Private loans (natural logarithm of net loans (in million of US dollars)). The main predictor is submarine, a binary variable for the arrival of the first fibre-optic submarine cable in the country. This dummy takes value zero before the arrival of the cable and 1 from the time of the arrival on. Obs. refers to the number of observations; Adj.R^2 is the adjusted R^2; M.D.V. refers to the mean of the dependent variable. Fixed effects are at the bank and year level. Standard errors in parentheses, clustered at country-year level. ***, ** and * indicate significance at the 1%, 5% and 10% level, respectively.

Appendix H

Appendix H refers to the robustness checks implemented on our sample of firms. Differently from the banking case, here we provide all the robustness sequentially, in a unique appendix.

Moreover, each of the robustness apply to both the diff-in-diff specification as defined by equation (2), and its modified version as defined by equation (3). Hence, for each subsection we show two tables: one with the single submarine coefficient, the other including also the interaction with “weak interbank”.

H1-H2 Country specific controls

We include country specific control variables in our main specification. We use the natural logarithm of GDP per capita to proxy for the economic development of the country, and the CPI rate to proxy for inflation. Tables H1 and H2 report the associated results.

Table H1: Staggered Diff-in-Diff - country controls

Variables	Access Finance (dummy)	Bank Credit (dummy)	Sales ln(USD)	Maturity ln(Months)
$submarine_{ct}$	0.112	0.101	2.348	0.122
	(0.0876)	(0.0836)	(1.583)	(0.280)
GDPpc	0.0157	0.152	-5.218	0.291***
	(0.296)	(0.216)	(6.334)	(0.0953)
CPI	-0.000434	0.00134	-0.0382**	0.00763
	(0.00146)	(0.00172)	(0.0145)	(0.0116)
Country FE	Yes	Yes	Yes	No
Year FE	Yes	Yes	Yes	Yes
Obs.	22696	22550	22117	1139
Adj. R^2	0.0911	0.124	0.360	0.171
M.D.V.	0.625	0.211	16.46	3.008

Notes: This table reports estimates from the staggered diff-in-diff design presented in equation (2). The dependent variables are as follows: Access to finance (dummy variable where 1 indicates easy access to finance); Loans from banks (dummy variable where 1 indicates at least one loan from a commercial bank); Sales (natural logarithm of the amount of total annual sales); Loans maturity (natural logarithm of the term, in months, of loans from banks). The main predictor is submarine, a binary variable for the arrival of the first fibre-optic submarine cable in the country. This dummy takes value zero before the arrival of the cable and 1 from the time of the arrival on. Other controls that we include are: the natural logarithm of GDP per capita and an index of inflation. Obs. refers to the number of observations; Adj.R^2 is the adjusted R^2; M.D.V. refers to the mean of the dependent variable. Fixed effects are at the country and year level. Standard errors in parentheses, clustered at country level. ***, ** and * indicate significance at the 1%, 5% and 10% level, respectively.

Table H2: Staggered Diff-in-Diff, ”weak interbank” - country controls

Variables	Access Finance (dummy)	Bank Credit (dummy)	Sales ln(USD)	Maturity ln(Months)
submarine$_{ct}$	-0.203	-0.0517	0.390	-0.289
	(0.120)	(0.0935)	(1.432)	(0.289)
submarine	0.279***	0.196***	2.556*	0.629**
$\times$ *weak intb*$_{ct}$	(0.0770)	(0.0587)	(1.400)	(0.242)
GDPpc	-0.251	0.0380	-6.060	0.337***
	(0.242)	(0.173)	(5.607)	(0.0856)
CPI	0.00334**	0.00247*	-0.0265*	-0.0105
	(0.00151)	(0.00135)	(0.0144)	(0.0131)
Country FE	Yes	Yes	Yes	No
Year FE	Yes	Yes	Yes	Yes
Obs.	22696	22550	22117	1139
Adj. R^2	0.0937	0.126	0.368	0.193
M.D.V.	0.625	0.211	16.46	3.008

Notes: This table reports estimates from the staggered diff-in-diff design presented in equation (2). The dependent variables are as follows: Access to finance (dummy variable where 1 indicates easy access to finance); Loans from banks (dummy variable where 1 indicates at least one loan from a commercial bank); Sales (natural logarithm of the amount of total annual sales); Loans maturity (natural logarithm of the term, in months, of loans from banks). The main predictors are: submarine, a binary variable for the arrival of the first fibre-optic submarine cable in the country. This dummy takes value zero before the arrival of the cable and 1 from the time of the arrival on; and submarine $\times$ weak interbank, the interaction between the dummy submarine and a dummy that specifies whether the country was below the median interbank activity before the arrival of the cable. Other controls that we include are: the natural logarithm of GDP per capita and an index of inflation. Obs. refers to the number of observations; Adj.R^2 is the adjusted R^2; M.D.V. refers to the mean of the dependent variable. Fixed effects are at the country and year level. Standard errors in parentheses, clustered at country level. ***, ** and * indicate significance at the 1%, 5% and 10% level, respectively.

H3-H4 Clusters survey

We cluster the errors by survey rather than by country. Results are provided in Tables H4 and H5.

Table H3: Staggered Diff-in-Diff - cluster survey

Variables	Access Finance (dummy)	Bank Credit (dummy)	Sales ln(USD)	Maturity ln(Months)
$submarine_{ct}$	0.150***	0.0580	2.247**	0.797***
	(0.0294)	(0.0354)	(1.083)	(0.245)
Country FE	Yes	Yes	Yes	No
Year FE	Yes	Yes	Yes	Yes
Obs.	25389	25222	24314	1139
Adj. R^2	0.0951	0.127	0.347	0.112
M.D.V.	0.638	0.211	16.43	3.008

Notes: This table reports estimates from the staggered diff-in-diff design presented in equation (2). The dependent variables are as follows: Access to finance (dummy variable where 1 indicates easy access to finance); Loans from banks (dummy variable where 1 indicates at least one loan from a commercial bank); Sales (natural logarithm of the amount of total annual sales); Loans maturity (natural logarithm of the term, in months, of loans from banks). The main predictor is submarine, a binary variable for the arrival of the first fibre-optic submarine cable in the country. This dummy takes value zero before the arrival of the cable and 1 from the time of the arrival on. Obs. refers to the number of observations; Adj.R^2 is the adjusted R^2; M.D.V. refers to the mean of the dependent variable. Fixed effects are at the country and year level. Standard errors in parentheses, clustered at survey level. ***, ** and * indicate significance at the 1%, 5% and 10% level, respectively.

Table H4: Staggered Diff-in-Diff, ”weak interbank” - cluster survey

Variables	Access Finance (dummy)	Bank Credit (dummy)	Sales ln(USD)	Maturity ln(Months)
$submarine_{ct}$	0.0437	-0.00197	0.185	0.587**
	(0.0436)	(0.0338)	(0.789)	(0.214)
$submarine$	0.160***	0.0977***	3.158***	0.418*
$\times$ $weak\ intb_{ct}$	(0.0460)	(0.0256)	(0.831)	(0.238)
Country FE	Yes	Yes	Yes	No
Year FE	Yes	Yes	Yes	Yes
Obs.	25389	25222	24314	1139
Adj. R^2	0.0965	0.127	0.362	0.127
M.D.V.	0.638	0.211	16.43	3.008

Notes: This table reports estimates from the staggered diff-in-diff design presented in equation (2). The dependent variables are as follows: Access to finance (dummy variable where 1 indicates easy access to finance); Loans from banks (dummy variable where 1 indicates at least one loan from a commercial bank); Sales (natural logarithm of the amount of total annual sales); Loans maturity (natural logarithm of the term, in months, of loans from banks). The main predictors are: submarine, a binary variable for the arrival of the first fibre-optic submarine cable in the country. This dummy takes value zero before the arrival of the cable and 1 from the time of the arrival on; and submarine × weak interbank, the interaction between the dummy submarine and a dummy that specifies whether the country was below the median interbank activity before the arrival of the cable. Obs. refers to the number of observations; Adj.R^2 is the adjusted R^2; M.D.V. refers to the mean of the dependent variable. Fixed effects are at the country and year level. Standard errors in parentheses, clustered at survey level. ***, ** and * indicate significance at the 1%, 5% and 10% level, respectively.

H5-H6 Regressions with firms inputs

We make a control exercise using firms inputs, rather than outputs, as our dependent variables. We define three variables for inputs: workforce, as the number of full-time employees in the firm; electricity, as the total annual cost of electricity; and raw materials, as the total annual cost of raw material. Estimates from our regressions are reported in Tables H5 and H6.

Table H5: Staggered Diff-in-Diff - Firm's inputs

Variables	Workforce ln(N)	Electricty cost ln(USD)	Raw Materials cost ln(USD)
$submarine_{ct}$	0.0763	2.415	3.385**
	(0.155)	(1.639)	(1.495)
Country FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Obs.	12637	23763	12554
Adj. R^2	0.129	0.421	0.335
M.D.V.	3.198	11.87	14.91

Notes: This table reports estimates from the staggered diff-in-diff design presented in equation (2). The dependent variables are as follows: Workforce (the natural logarithm of the amount of total full-time employees); Electricity cost (the natural logarithm of electricity costs in US$); Raw materials cost (the natural logarithm of row materials costs in US$). The main predictor is submarine, a binary variable for the arrival of the first fibre-optic submarine cable in the country. This dummy takes value zero before the arrival of the cable and 1 from the time of the arrival on. Obs. refers to the number of observations; Adj.R^2 is the adjusted R^2; M.D.V. refers to the mean of the dependent variable. Fixed effects are at the country and year level. Standard errors in parentheses, clustered at country level. ***, ** and * indicate significance at the 1%, 5% and 10% level, respectively.

Table H6: Staggered Diff-in-Diff, "weak interbank" - Firm's inputs

Variables	Workforce ln(N)	Electricty cost ln(USD)	Raw Materials cost ln(USD)
$submarine_{ct}$	-0.231	0.925	2.006
	(0.202)	(1.311)	(1.447)
$submarine$	0.356**	2.371	2.067
$\times$ $weak\ intb_{ct}$	(0.148)	(1.456)	(1.518)
Country FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Obs.	12637	23763	12554
Adj. R^2	0.129	0.429	0.340
M.D.V.	3.198	11.87	14.91

Notes: This table reports estimates from the staggered diff-in-diff design presented in equation (2). The dependent variables are as follows: Workforce (the natural logarithm of the amount of total full-time employees); Electricity cost (the natural logarithm of electricity costs in US$); Raw materials cost (the natural logarithm of row materials costs in US$). The main predictors are: submarine, a binary variable for the arrival of the first fibre-optic submarine cable in the country. This dummy takes value zero before the arrival of the cable and 1 from the time of the arrival on; and submarine × weak interbank, the interaction between the dummy submarine and a dummy that specifies whether the country was below the median interbank activity before the arrival of the cable. Obs. refers to the number of observations; Adj.R^2 is the adjusted R^2; M.D.V. refers to the mean of the dependent variable. Fixed effects are at the country and year level. Standard errors in parentheses, clustered at country level. ***, ** and * indicate significance at the 1%, 5% and 10% level, respectively.