High-Speed Internet, Financial Technology and Banking*

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Abstract

We exploit the staggered arrival of submarine cables in Africa to study how high-speed internet affects financial technology and banking. Combining country and bank reports with a machine-learning algorithm, we build a dataset on a technology central for bank intermediation: the real-time gross settlement system (RTGS). High-speed internet increases RTGS adoption, leading banks to lower liquidity hoarding, increase interbank transactions and private-sector lending. We identify a distinct credit supply channel through banks connected to high-speed internet both through their multinational network and country of operation. RTGS adoption produces real effects on firms in countries with weak pre-existing interbank markets.

JEL: G2, G21, O16, O12
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1 Introduction

How does financial technology, or FinTech, shape the business of banking? A recent 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)). However, there is still limited understanding and quantitative evidence on whether, and how, financial technology shapes business "inside" the bank.

In this research, we explore the relationship between high-speed internet, financial technology and banking. We show that the arrival of high-speed internet promotes the adoption of a financial technology central for bank intermediation: the real-time gross settlement system (RTGS). This technology affects bank liquidity management leading to a reduction in liquidity hoarding and an increase in interbank transactions and private-sector lending. The mechanism behind this effect is in line with Coase (1960): innovative financial technologies lower transaction costs in interbank exchanges and enhance integration in liquidity markets (Townsend (1978), Zilibotti (1994), Guerrieri and Lorenzoni (2009)). In turn, this lowers liquidity risk and stimulates private-sector lending (Choudhary and Limodio (2017)).

While a small literature shows that high-speed internet promotes information and communication technologies, ICT, (Augereau and Greenstein (2001)), and fosters the adoption of the RTGS (Bech and Hobijn (2006)), much less is known on how the RTGS adoption shapes banks and their functions. To investigate this point, it is essential to highlight that the RTGS introduces a system of interbank transactions in which money and securities are exchanged with two unique features. First, the transactions happen in "real-time", implying that a payment is immediately executed and does not require waiting periods. Second, a "gross settlement" takes place in a one-to-one manner between the parties in the exchange, without bundling or netting with other trades.

Because of this technology, both the access and liquidity of the interbank market can increase as the speed of transactions surges (Biais et al. (2015), Farboodi and Veldkamp (2019)), network externalities strengthen (Higgins (2019)) and the credit risk due to settlement lags declines. Therefore, while high-speed internet can directly improve business opportunities (Hjort and Poulsen (2019)), it can also have a separate effect on liquidity markets. In fact, this paper offers evidence consistent with high-speed internet promoting the RTGS technology, which intensifies participation in the interbank market and, as a result, reduces liquidity hoarding and promotes lending.[1]

To study this issue, 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. This 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 it offers ample power for two reasons. First, the magnitude of the effect is large. 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 used by most 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. Figure 1 offers two pictures consistent with the high transaction costs and weakness of liquidity markets in Africa. The left panel shows that poorer countries present underdeveloped interbank markets, especially in Africa (indicated with a square). The right panel shows that African banks hoard vast amounts of liquid assets, between 45 and 55 per cent of their liabilities, in line with presenting dysfunctional interbank markets.

We combine this unique experiment with four comprehensive datasets. First, we track the exact geography and timing of submarine cable arrival in Africa between 2000 and 2013. Second, we build a novel dataset containing bank-level information on RTGS adoption, by combining country-level reports, annual bank reports and a machine-learning algorithm. Third, we gather a bank-level dataset following 489 African banks and containing information on their balance

[1]This result would emerge in models of liquidity hoarding, like Bolton et al. (2011) and Heider et al. (2015). In these models, 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. As high-speed internet reduces the cost of interbank exchanges, banks re-adapt their optimal liquidity management by lowering hoarding and increasing their interbank activity.

sheets, including liquid assets, interbank activities and lending from Bankscope and Bankfocus. Forth, we construct a dataset following 28,171 firms in Africa from the World Bank Enterprise Surveys (WB ES) 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 five 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 (probability of RTGS adoption, interbank activity, liquidity hoarding and lending). However, after the cable arrival, treated banks are much more likely to adopt the RTGS, use more extensively the interbank market, increase lending 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 aggregate effect of submarine cables on the main dependent variables. We find that the probability of adopting the RTGS technology increases by 14%, private-sector lending increases by 17%, interbank loans and deposits grow by 15% and 50% respectively, and liquidity hoarding declines by 21%. We also explore a sharper specification pointing toward the explicit improvement in the terms and 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 investigate further the mechanism on the effects of high-speed internet on interbank markets. We suppose that the adoption of the RTGS 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 in the interbank market. This result remains true even once we exclusively focus on the cross-sectional within-country-year variation comparing weak interbank users to strong users by including country $\times$ year fixed effects, which factor out the arrival of the cable itself.

Fourth, we identify the distinct effect of high-speed internet on credit supply by focusing on multinational banks. These banks present multiple branches that operate at the same time in different countries. We exploit the fact that a bank in a country that does not receive high-speed internet, may still gain access to a deeper interbank market because its multinational group receives a high-speed internet connection through banks in other countries. Hence, we define high-speed internet connectedness at the level of both the bank group and country of operation. Through this, we verify that as banks receive internet access also via their multinational network, they significantly lower liquidity hoarding, increase interbank activity and private-sector lending more than banks in the same country lacking internet access. This finding is robust to including various fixed effects to remove some key unobservables. We partial out country × year fixed effects, absorbing country-specific demand shocks (like the arrival of the cable in the country itself) and also group × year fixed effects, removing shocks to the multinational bank as a whole (like shocks to within-group liquidity).

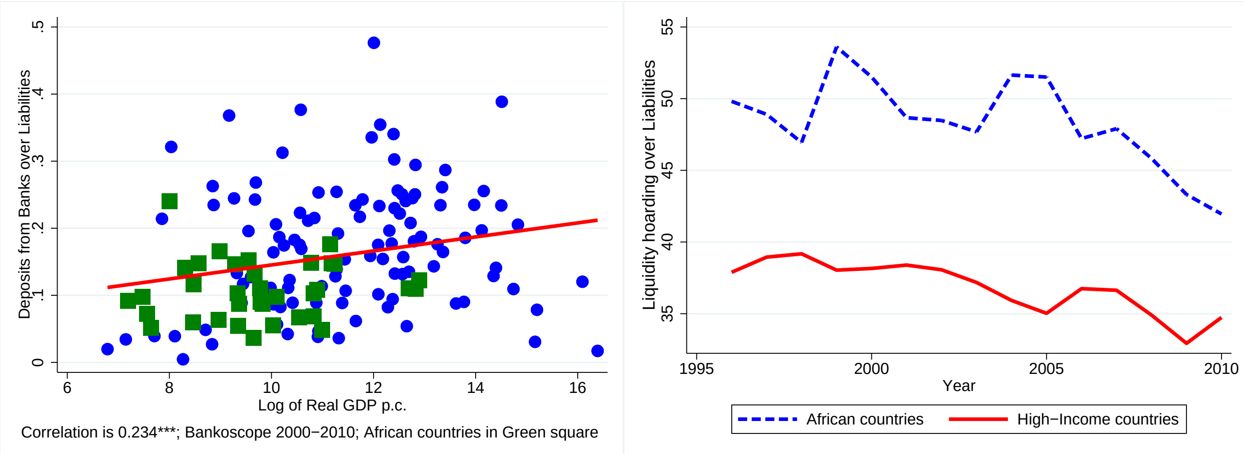
Finally, we explore firm-level data to investigate how high-speed internet affects firms, whether there is a relation between high-speed internet, interbank markets and firm outcomes. We structure this exercise through two tests. In the first, we verify that firms in countries experiencing the arrival 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 in 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, 50% longer loan maturities and a sizeable expansion in yearly sales. The result on loan maturities is particularly important and in line with a liquidity story. As banks face lower costs of interbank transactions, this reduces their liquidity risk, making long-term loans cheaper and more extensive, as Choudhary and Limodio (2017) find in Pakistan.

To verify the robustness of our results, we devote an extended section and appendix to explore alternative empirical specifications and explanations. We show that results are robust to: a) the inclusion of landlocked countries, originally excluded from the analysis due to their lack of oceanic cables; b) extending the banking sample from 2013 to 2018, by combining two different banking datasets; c) focusing the sample on banks with non missing observations; d) exploring alternative definitions of weak interbank usage. Then, we also verify 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 outcomes.

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)).[2] The closest papers on this topic focus on the effects of payment systems and technology on individual and firm behaviour. Higgins (2019) exploits a natural experiment generating an exogenous increase in the adoption of debit cards in Mexico, which creates spillovers on other technologies and sizable consumer gains. The results of Higgins (2019) suggest that financial technology changes individual transaction costs and affects consumption, which is in line with our mechanism involving banks and liquidity management. Steinwender (2018) studies the introduction of the transatlantic telegraph in 1866, which lowered transaction costs and information frictions, leading to increased trade flows in cotton and lower and more stable prices. Benetton et al. (2019) show that while novel payment systems and their creation through cryptomining improve the local economic environment, its "mining" component can generate adverse effects and crowds out other economic activities. Two innovative papers analyze the effect of submarine cables on finance and the local economy. Eichengreen et al. (2016) study the effect 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. Hjort and Poulsen (2019) show that submarine cables improve 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. Second, 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), Diamond and Dybvig (1983), Bencivenga and Smith (1991), Saint-Paul (1992), Zilibotti (1994), Acemoglu and Zilibotti (1997), Goldstein and Pauzner (2005), 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, four papers offer the latest insights about its functioning. Heider et al.

[2]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.

(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. Craig and Ma (2018) model how intermediation arrangements emerge in the interbank market and quantify how shocks are transmitted across the network. Coen and Coen (2019) examine the trade-off between surplus and risk propagation in the interbank market through a structural model.

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 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. 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.

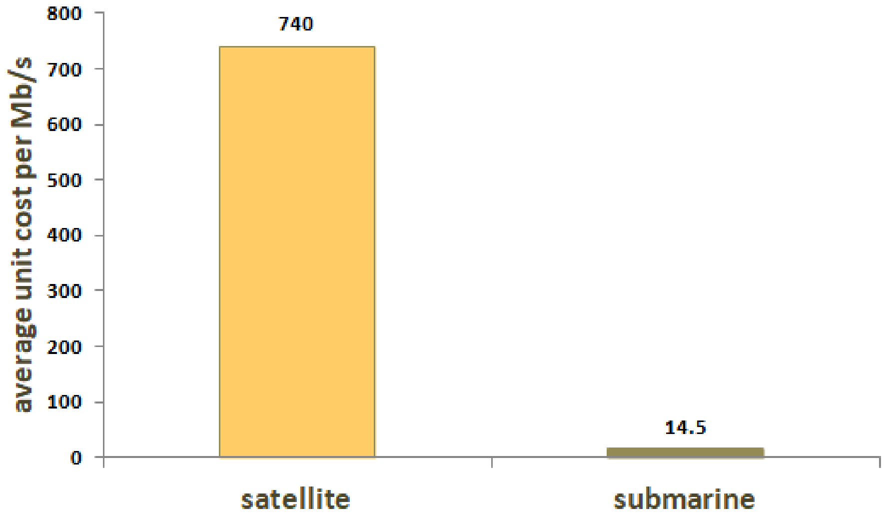
At the turn of the 19th and the 20th century, the science of transmitting higher frequencies was established. However, commercialization was delayed by the two World Wars and the Great depression. The first modern submarine cable, TAT-1 (Transatlantic No. 1), a coaxial cable insulated using polyethylene 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.[3] 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 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 worldwide are carried on low cost modern fibre-optic submarine cables.[4] 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,

[3] 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.

[4] 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.

Figure 2: Internet Cost per Mbit/s Transported



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

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. High-speed connection improves some key functions of banking: from the screening and scoring of customers, to the internal information processing and the 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 markets, 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, securities 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).[5] The connection to the submarine cables determines whether a bank can operate in real

[5]On December 26 of 2006, the Hengchun earthquakes occurred off the southwest coast of Taiwan, in a zone which connects the South China Sea with the Philippine Sea. The earthquakes not only caused casualties and building damage, but several submarine communications cables were cut, disrupting telecommunication services in various parts of Asia. The earthquakes catastrophically disrupted Internet services in Asia, affecting many Asian countries as China and Hong Kong. Consequences on financial transactions were important as well. In particular, the foreign exchange market was seriously affected. It was only the capillary presence of other submarine cables that avoided the instant halt of foreign exchange transactions.

time with a long list of counterparties on the interbank market. As a consequence, the banking network, interbank operations and the speed of transactions can vary dramatically depending on whether the bank has access to the 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 high-speed internet shapes banking via interbank markets. In this process, we take the arrival of fibre-optic cables as an exogenous technological shock that positively impacts banking and credit supply. In fact, it is important to highlight that the arrival of submarine cables in Africa was mostly due to the need to increase connectivity between America, Europe and Asia.

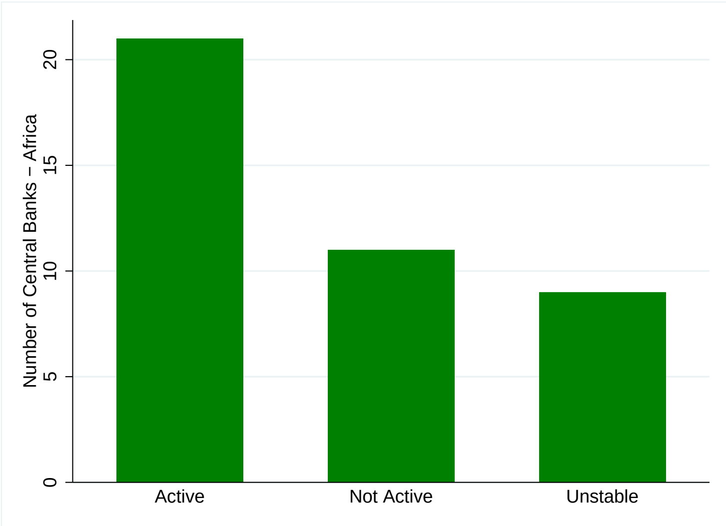
Our empirical analysis capitalizes on three main facts. First, we acknowledge that before the arrival of submarine cables, the interconnection of national banking networks in Africa was mostly based on satellites (African Development Fund (2002)). In that regard, fibre-optic technology represents a major shock to banks, as they transition from an expensive to a much cheaper technology. Second, we note that geography matters for the timing of arrival. 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 endogeneity issues coming from the fact that submarine cables have had the explicit purpose to improve banking. In fact, our sample ranges from 2000 to 2013, whereas Hibernia Express, which was tested in September 2015, was the first submarine cable laid for the express purpose to foster electronic trading in financial markets (Eichengreen et al. (2016)). Before that time, fibre-optic cables had 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

Africa constitutes the best laboratory to explore our research question. 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 limited functioning of local liquidity markets, which exacerbates deposit shocks. Third, the staggered arrival of submarine cables provides the ideal setting for econometric investigation. Therefore, we think that statistical power in our setting is moderately high and that, among the reasons behind the effect of fibre-optic technology on banking, there is a critical impact generated by the 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). It confirms that more than 50% of central banks are not actively engaged in these operations, based on documentation either local or published by the International Monetary Fund and the World Bank.

Figure 3: The Status of Discount Window Facilities in Africa



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 technologies, can dramatically reshape the financial system and generate cascade effects on credit supply and firms.

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 RTGS Adoption and Machine-Learning

The arrival of high-speed internet in Africa, through fibre-optic submarine cables, led to a profound transformation of the banking system. Among the critical changes that modernized local banks, a prominent role has been played by a technology heavily relying on fast internet connections: the real-time gross settlement system (RTGS).

Real-time gross settlement (RTGS) systems are special interbank transfer systems where the transfer of money and securities takes place on a "real-time" and "gross" basis. RTGS systems are typically used for low-volume, high-value transactions and their purpose is to reduce credit risks due to settlement lags. Real-time systems exhibit an inherent trade-off. On the one hand, they reduce information asymmetries by giving an accurate picture of an institution's account at any point in time, thus lowering settlement risk. On the other hand, they require large amounts of liquidity in the system to work properly, which is a major shortcoming in a market that deals with short-term liquidity shocks.

In Africa, settlement risk represents a core friction for the expansion of interbank markets. As a result, RTGS systems are seen in favourable light by practitioners and their adoption is related to more advanced and efficient interbank markets.[6] [7] This technology has been often promoted by transnationals economic unions, like the Southern African Development Community in Southern Africa (SADC), the West African Economic and Monetary Union

[6]It is important to notice that the 24 principles for financial markets infrastructures published in April 2012 by the Committee on Payment and Settlement System (CPSS) and the Technical Committee of the International Organisation of Securities Commission (IOSCO) emphasise final settlement in central bank money, in real time, as the new global standard.

[7]RTGS systems have become crucial infrastructures in the modern financial system. In 2014, during the Second Libyan civil war, the Government of National Accord, through the Central Bank based in Tripoli, disconnected its two eastern branches from its automated clearing system, the Real-Time Gross Settlement (RTGS). The eastern branches were under the control of the competing faction, the Libyan National Army of general Khalīfa Belqāsim Haftar, and this move had the specific aim to prevent east-based authorities from accessing government accounts and funds and to limit their access to finance.

in West Africa (WAEMU) and the Economic Community of Central African States in Central Africa (CEMAC). At the same time, individual countries and banks have also invested in RTGS with the explicit aim to reduce credit risk and deepen their access to liquidity markets.

To build a bank-specific database on the adoption of RTGS, we use two sources of information: country-level reports and bank-level reports. While the year of adoption of RTGS at the country level is often public information, released by central banks or telecommunication authorities, it is generally difficult to retrieve information on RTGS adoption at the bank level. For this reason, in this section (and more accurately in Appendix A) we develop a machine learning algorithm which aims to predict the year in which a specific bank joins the RTGS system of its country. In this way, we build a novel dataset on the adoption of the RTGS technology at the bank level.

Our conceptual exercise seeks to solve the following equation:

$$Y_{ic} = f(X^1_c, X^2_{ct}, X^3_{ict})$$

where Y_{ic} represents the year of adoption of RTGS for bank i in country c; X^1_c are variables at the country level: a dummy variable that indicates whether the country in which the bank operates is part of the SADC, WAEMU or CEMAC, and the year of arrival of high-speed internet in country c; X^2_{ct} reports two dummies that indicate the presence of RTGS and high-speed internet in country c at time t; finally, X^3_{ict} indicates balance sheet variables that refer to bank i in country c at time t.

Because there is no clear functional form for the above expression, we employ an array of machine-learning algorithms to investigate the optimal form of $f(.)$. As reported in greater detail in Appendix A, we use the following models: 1) Elastic net; 2) Support Vector Machine (linear kernel, radial kernel, sigmoid kernel); 3) Trees (random forest, bagging, boosting); 4) Neural Network.

To train and check the accuracy of our algorithm, we manually collect information for a sample of more than 300 banks in 22 African coastal countries by retrieving information from central bank reports, newspapers, telecommunication authorities and banks. Then, to assess the effectiveness of our exercise, we combine two criteria to evaluate the output of different algorithms: the mean square error (MSE), which offers a summary statistic on the average squared error of our predictions; and a graphical comparison of the predictions from our algorithms and the actual values of RTGS adoption. The combination of these two tests indicate that the bagging algorithm delivers the most accurate results.

Section 2.4 reports summary statistics on our predicted variable: the dummy RTGS adoption at the bank level. Further information on the estimates from the machine learning and summary outcomes are reported in Appendix A, with an extensive methodological explanation.

2.4 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 (WB GFDD) and the World Bank Worldwide Governance Indicators (WB WGI). 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. In the robustness section, we use the new BankFocus database by Bureau van Dijk to fill some of the missing that are in Bankscope and, most importantly, to extend 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 (WB ES). This offers an 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 622 banks, in 97 cities, for 52 countries in Africa, during the period 2000-2013.[8] 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.[9] Therefore, our final sample considers 489 banks, in 80 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 is well-spread across countries.[10]

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. Moreover, 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 transactions. 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 (mostly country headquarters)

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

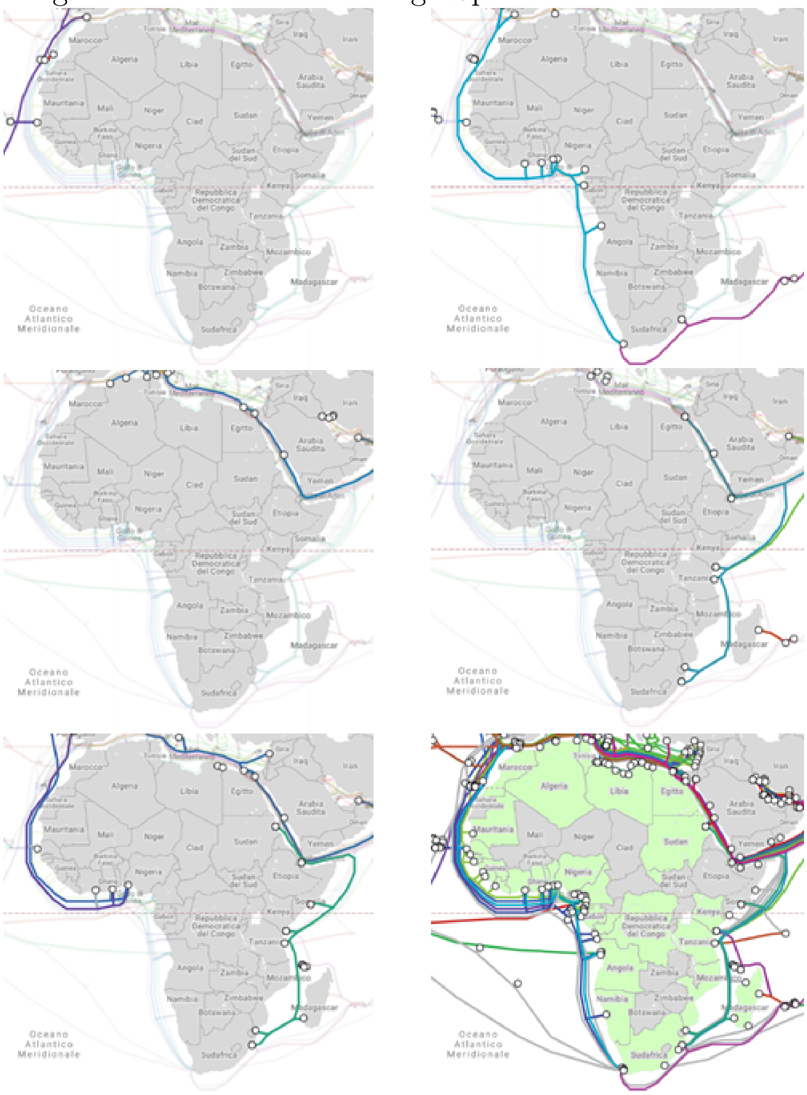
[9] We include landlocked countries in one of the robustness checks and we consider them as non-treated.

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

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.[11] 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.

Figure 4: The Arrival of High-Speed Internet 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

[11] Appendix B 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.

effects of the new technology on interbank markets and credit supply, we focus on the following dependent variables: Loans to banks 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 whether 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 0 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 sector, 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	(I) Obs.	(II) Mean	(III) Std. Dev.	(IV) Median	(V) 5th P.tile	(VI) 95th P.tile
	Panel A - Dependent variables: banks (2000-2013)					
RTGS adoption	3,886	0.466	0.499	0	0	1
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
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	24,065	12.114	2.843	11.807	8.009	17.247
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	3,767	0.254	0.435	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: RTGS adoption (dummy variable where 1 indicates that the bank adopted the RTGS system, obtained through a machine-learning algorithm); 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)); 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.

2.5 Empirical Methodology

In this section, we present our empirical strategy that makes use of four different methodologies.

First, we develop an event study design meant to test for pre-trends and to investigate the dynamics of the treatment effect. Second, we implement a staggered diff-in-diff design using two-way fixed effects regressions. 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 refine our estimates 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 factor out specific unobservables. Fourth, we offer a specific test to identify the existence of a distinct credit supply effect by focusing on multinational banks.

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

The first specification that we propose is an 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 treatment effect. The empirical specification that we test is as follows:

$$Y_{ict} = \alpha_i + \beta_t + \gamma_{-5} I \left\{ K_{ct} \leq -5 \right\} + \sum_{k=-4}^{4} \gamma_K I \left\{ K_{ct} = k \right\} + \gamma_{5+} I \left\{ K_{ct} \geq 5 \right\} + \varepsilon_{ict} \quad (1)$$

where: Y_{ict} represents the dependent variable[12], for bank i, in country c, at time t; α_i and β_t are bank and year fixed effects; K_{ct} is the relative year from the activation of the cable (ACT_c), $K_{ct} = t - ACT_c$; γ_{-5} is the single coefficient for far leads; and γ_{5+} 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.[13] We assign value 1 to the dummies that are at the extremes of the

[12] Dependent variables are: Loans to banks 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.

[13] We have tried with different specifications of the event window (see the Appendix for the 3 years window). Results are particularly stable.

event window, where $-5 \geq K_{ct} \geq 5$ and set the year before the arrival of the submarine cable as the baseline category, as standard in the literature.

The second specification that we propose is a canonical staggered difference-in-difference 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 dynamic specification, it imposes no pre-trends and constant treatment effects. Hence, the staggered diff-in-diff 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 bank (firm) and year fixed effects; and D_{ct} is a dummy variable that equals one after the arrival of the first submarine cable in country c and zero before.

The third specification that we propose is a modified version of the staggered diff-in-diff methodology that allows for the inclusion of 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 that takes value 1 if the bank was below the median of loans to banks before the arrival of high-speed internet, and zero otherwise.[14]

In the second part of the analysis, when dealing with firms, 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:

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

[14] A similar exercise, considering an indicator of weak borrower, is presented as a robustness check (see the Appendix).

where: Y_{ict} represents the dependent variable, for bank (firm) i, in country c, at time t; α_i and β_t are the bank (firm) and year fixed effects; D_{ct} is a dummy variable equal to one after the arrival of the first submarine cable in country c; and $X_{i(c)}$ is the bank (country) specific heterogeneity. Notice that the presence of the dummy D_{ct} and its interaction term with $X_{i(c)}$ is not coupled by the inclusion of $X_{i(c)}$ alone, as the latter is absorbed by bank (or country) fixed effects. We also strengthen our findings by augmenting equation (3) with the inclusion of country-year fixed effects.

Finally, the fourth specification is meant to verify whether a distinct credit supply effect takes place. This would be induced by a lower marginal cost of credit supply as transaction costs in the interbank market decline. To identify this, we augment equation (3) by defining high-speed internet connectedness at the level of bank-group g, moving from D_{ct} to D_{gt}, and study the following specification:

$$Y_{igct} = \alpha_i + \beta_t + \gamma_g + \mu_1 D_{gt} \times X_i + \mu_2 D_{gt} + \varepsilon_{igct} \tag{4}$$

where: Y_{ict} represents the dependent variable, for bank i belonging to group g in country c at time t; α_i, β_t and γ_g are the bank, year and group fixed effects; D_{gt} is a dummy variable equal to one after the arrival of the first submarine cable in any of the branches of bank group g; and X_i is the weak lender dummy, taking unit value if the bank was below the median of loans to banks before the arrival of high-speed internet, and zero otherwise. In this setting, μ_1 captures the average effect affecting bank i when the first branch of group g, regardless of the country, receives high-speed internet (and μ_2 measures the heterogeneity on weak lenders). In order to account for country time-varying and group time-varying unobservables, we include σ_{ct} and γ_{gt} respectively, focusing on the variation within-bank and within-group comparing big and small lenders.

3 Results

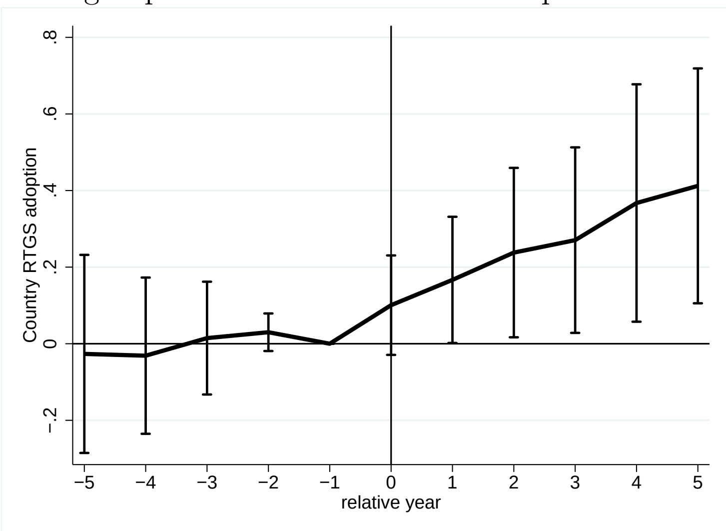
This section reports the main results from the empirical analysis.

Following the structure of the paper, we divide the section into three subsections. In the first subsection, we explore the relation between high-speed internet and financial technology adoption. We employ the event study and the staggered diff-in-diff design using as dependent variables the probability that a country and a bank adopt the RTGS technology. The second subsection focuses on banking outcomes. We present estimates from the event study, the staggered diff-in-diff, and the diff-in-diff with heterogeneity and identify a distinct credit supply effect in line with the argument of financial technology adoption. In the third and final subsection, we study the real effects focusing on firms outcomes.

3.1 Financial Technology Adoption

Our first piece of evidence is at country-level. Figure 5 shows the relationship between the arrival of high-speed internet and the probability that a country adopts the RTGS technology in an event-study design. As we can see from the figure, there is a positive and increasing relationship between the two variables. This was to be expected as high-speed internet works as a pre-condition for the adoption of real-time technologies. This is in line with Augereau and Greenstein (2001), Bech and Hobijn (2006) and our hypothesis that internet speed and connection reliability foster the take-up of financial technologies.

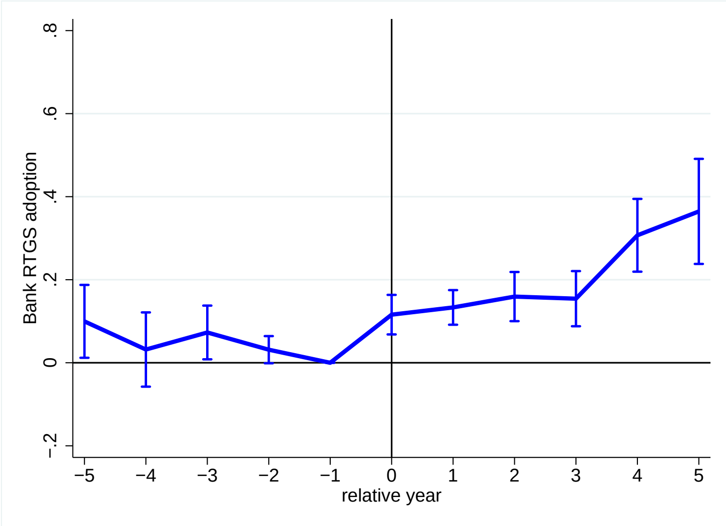
Figure 5: High-Speed Internet and RTGS adoption - Country level



Notes: Event study. On the y axis: probability of RTGS adoption at the country level. On the x axis: the relative time from the arrival of the first submarine fiber-optic cable. The black line connects point estimates relative to the base year (-1). Confidence intervals are also reported.

Figure 6 replicates the same event study at the bank level. As explained in section 2.3, the outcome variable is the predicted value of RTGS adoption obtained combining country information, bank reports and a machine-learning algorithm. In line with Figure 5, high-speed internet connection promotes the RTGS adoption.

Figure 6: High-Speed Internet and RTGS adoption - Bank level



Notes: Event study. On the y axis: probability of RTGS adoption at the bank level. 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.

In Table 2, we compactly present estimates from the staggered diff-in-diff design as defined in equation (2). Column 1, refers to the RTGS adoption at the country level. Columns 2 to 4, refer to the RTGS adoption at the bank level, with this unobservable variable being proxied in different ways. Column 2 extends the results of Column 1, by assuming that all banks in a country adopt the RTGS as the country introduces this technology. Column 3 uses a dummy variable obtained from a machine-learning algorithm analogous to the one introduced in section 2.3, but excluding all country-level information (Version 1 in Column 3). Finally, Column 4 reports our preferred specification, which uses as a dependent variable the RTGS dummy obtained from the machine-learning algorithm as explained in section 2.3 (Version 2 in Column 4). Results from the different specifications show that high-speed internet connection positively affects the adoption of RTGS in the country and, within countries, it positively affects the probability that the single bank joins the real-time gross settlement system.[15]

[15]The fact that the coefficient at the country level is larger in magnitude with respect to the coefficients at the bank level clarifies that not all the banks adopt RTGS when it is available. The latter is of particular interest and in line with what we know about the US interbank market and Fedwire adoption.

Table 2: Staggered Diff-in-Diff - RTGS adoption

Variables	(I) RTGS	(II) RTGS	(III) RTGS Version 1	(IV) RTGS Version 2
$Submarine_{ct}$	0.141*	0.0462*	0.0499**	0.0642***
	(0.079)	(0.0237)	(0.0249)	(0.0241)
Country FE	Yes	No	No	No
Bank FE	No	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Obs.	466	3879	3860	3863
Adj. R^2	0.652	0.724	0.747	0.772
M.D.V.	0.405	0.497	0.475	0.468

Notes: This table reports estimates from the staggered diff-in-diff design presented in equation (2). The dependent variables are: RTGS adoption at the country level; RTGS adoption at the bank level (where RTGS=1 once the country adopt RTGS); RTGS Version 1, the first version of predicted adoption of RTGS at the bank level, using machine learning techniques; RTGS Version 2, the second version of predicted adoption of RTGS at the bank level, using machine learning techniques (more information on ML algorithms and estimates in the Appendix). 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 (country in column 1) and year level. Standard errors in parentheses, clustered at bank (country in column 1) level. ***, ** and * indicate significance at the 1%, 5% and 10% level, respectively.

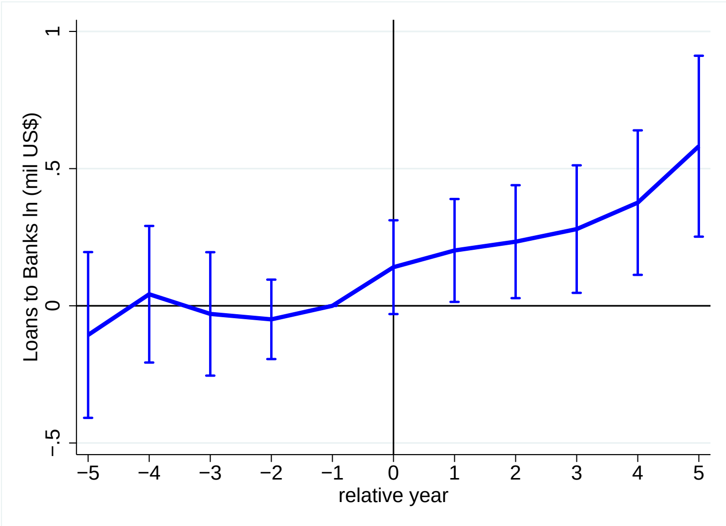
3.2 Banking

This subsection focuses on the effects of submarine cables on banking.

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 by means of several figures. Each figure refers to a specific dependent variable, where our dependent variables proxy for interbank activity, liquidity holding and credit supply to the private sector. All the figures share common attributes: the observation window ranges from 2000 to 2013; the event window is defined over the interval [-5;+5], meaning that we consider a five-years window 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 indicates the year of arrival; year -1 is the baseline category; and, finally, the y-axis reports the dependent variable.

The first two figures refer to banks interbank activity. Figure 7 shows the relative (to the base year) dynamics of the treatment effect for bank's loans to other banks. As we can see, no pre-trends can be detected. Before the arrival of the submarine cable, point estimates are close to zero and none of them is statistically significant. On the other hand, the trend becomes upward and estimates are statistically significant after the introduction of high-speed internet. We observe a jump at year zero and a gradual increase in loans to banks in the following years.

Figure 7: High-Speed Internet and Loans to Banks

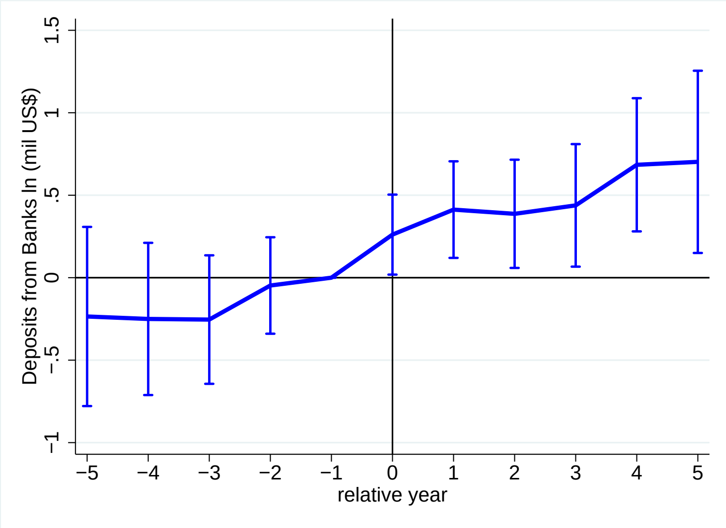


Notes: Event study. On the y axis: ln(loans to banks). On the x axis: the relative time from the arrival of the first submarine fiber-optic cable. The blue line connects point estimates relative to the base year (-1). Confidence intervals are also reported.

Figure 8 replicates the same estimates 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. This finding is interesting and needs further investigation. However, it seems to suggest that the disposable of the new technology, that decreases transaction costs for interbank operations and reduces lending risk within the interbank market, changes the relationships among banks. Small and marginal banks benefit from the reduced interbank lending risk and lend their excess liquidity to big and core banks. Big and core banks, that mostly compose our sample, act as liquidity hubs and use these new funds to lend to the private sector.[16]

[16] This occurrence is even more plausible if lending risk outside of the interbank market does not decrease.

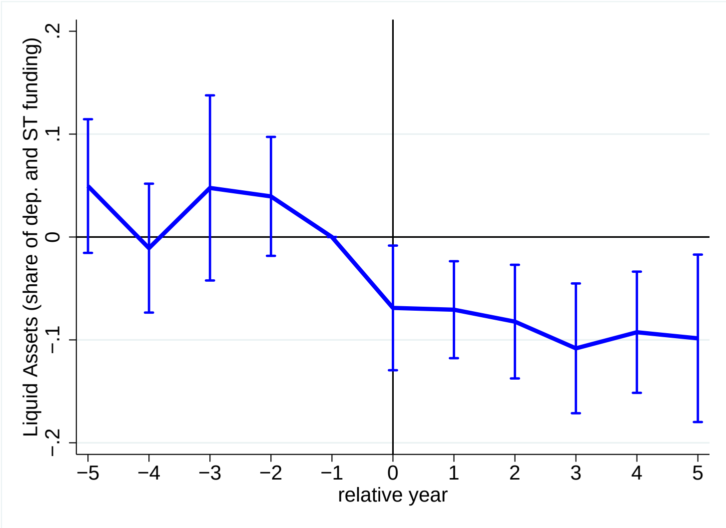
Figure 8: High-Speed Internet and Deposits from Banks



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 9 refers to the amount of bank's liquid assets as a share of deposits and short-term funding. A priori, we expect no pre-trends and a significant decline in the amount of liquid assets once the new internet technology is available. High-speed internet reduces transaction costs for interbank transactions, allowing interbank markets to be effective in smoothing for liquidity shocks. In this way, banks can substitute unprofitable hoarding of liquid assets with real-time interbank transactions, thus increasing the profitability of their portfolio. Figure 9 seems to confirm this hypothesis. The pattern for the share of liquid assets is almost flat before the arrival of high-speed internet, with none of the estimates statistically significant. Then, it sharply declines at year zero and remains negative and stable over the following years.

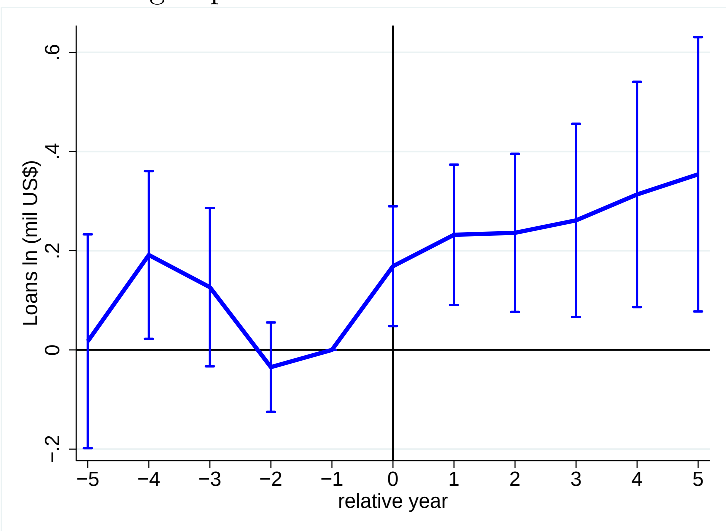
Figure 9: High-Speed Internet and Liquid Assets



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 10 focuses on the supply of private credit and 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, and finally leads banks to invest part of these funds in the private sector. Figure 10 confirms this hypothesis. First, there are no clear pre-trends (even if some of the estimates can be different from zero). Second, credit to the private sector undergoes a substantial and persistent increase after the landing of the first fibre-optic submarine cable.

Figure 10: High-Speed Internet and Private-Sector Lending



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 blue line connects point estimates relative to the base year (-1). Confidence intervals are also reported.

To summarize, evidence from the event study suggests the following two 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 a quite persistent dynamics. 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. 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 with 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 3, where each column refers to a specific dependent variable.[17] Results from Table 3 are in line with those presented in the event study. Having access to the fibre-optic technology determines an increase in loans to banks and deposits from banks, 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% level) and they are large in magnitude. The introduction of 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 of 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 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-optic technology causes a decrease in the share of liquid assets over deposits and short-term funding of about 10 percentage points (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.

[17] Remember that our dependent variables are: the two different proxies of interbank activity; liquid assets as a share of deposits and short-term funding; and private loans.

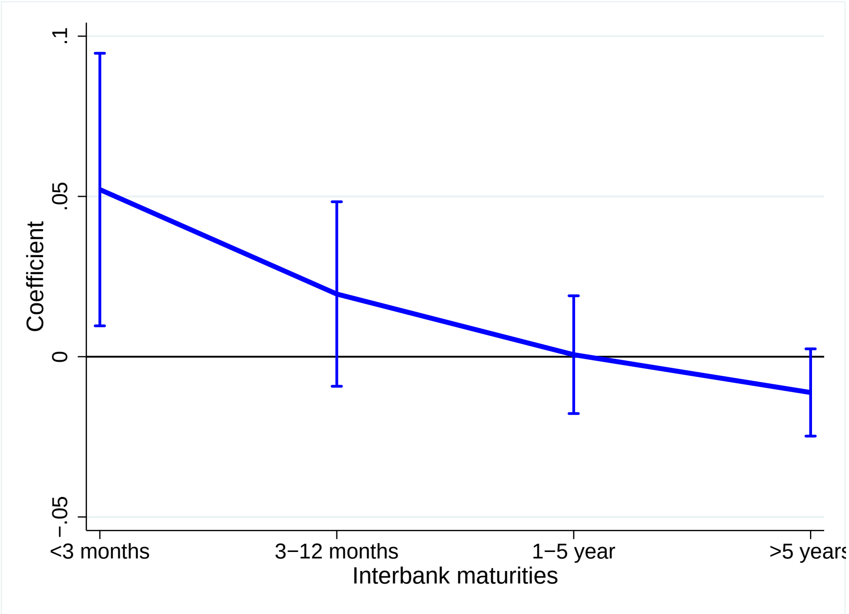
Table 3: Staggered Diff-in-Diff - Interbank, Liquidity and Loans

Variables	(I) Liquid Assets (share DST)	(II) Loans to Banks ln(milUS$)	(III) Deposits from Banks ln(milUS$)	(IV) Private loans ln(milUS$)
$Submarine_{ct}$	-0.0961***	0.139	0.411***	0.157**
	(0.0220)	(0.0894)	(0.132)	(0.0687)
Bank FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Obs.	3837	3536	2754	3821
Adj. R^2	0.430	0.828	0.715	0.891
M.D.V.	0.463	3.744	2.690	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)); 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 implement an additional 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 regard, we expect a relative increase in short-term interbank transactions with respect to longer-term transactions once the fibre-optic technology is 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 11. As we can see, coefficients associated to banks 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). Hence, we would interpret these findings simply as suggestive and intend to further investigate for higher-quality data.

Figure 11: High-Speed Internet and Interbank Maturities



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

To summarize, results from the staggered diff-in-diff design confirm those of the event studies. The effects on banking associated to high-speed internet 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. This 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 that takes value 1 if the bank was below the median of loans to 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 4 presents the results.[18]

[18] In the Appendix, we also propose different measures of the core heterogeneity. In Table D1 we focus on each single country and we define a bank to be a weak lender if it was below the median value, in the country, before the arrival of high-speed internet. Results are in line with those reported here. In Table D2, we repeat the same exercise but using weak borrower as the core heterogeneity. Finally, in Table D3 we use country-year fixed effects in the specification with weak borrower.

Results fro Table 4 are in line with our hypothesis. Most of the previous findings are 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 are behind the increase in loans to and deposits from banks and are the ones that mostly increase the amount of lending to the private sector. Indeed, we have suggestive evidence that the arrival of fibre-optic cables, reducing transaction costs for interbank transactions, widens interbank markets and makes it possible for marginal players to become more involved in the banking network and to expand their opportunities of lending.

Table 4: Staggered Diff-in-Diff - Weak Lender

Variables	(I) Liquid Assets (share DST)	(II) Loans to Banks ln(milUS$)	(III) Deposits from Banks ln(milUS$)	(IV) Private loans ln(milUS$)
$Submarine_{ct}$	-0.0501**	-0.0848	0.0527	-0.0478
	(0.0251)	(0.113)	(0.148)	(0.0955)
$Submarine$	-0.0949***	0.441***	0.772***	0.382***
$\times$ $Weak\ Lender_{ict}$	(0.0338)	(0.162)	(0.221)	(0.121)
Bank FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Obs.	3720	3514	2710	3715
Adj. R^2	0.475	0.830	0.717	0.892
M.D.V.	0.461	3.750	2.696	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)); 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 5 below. As we can see, estimates remain almost unchanged, whereas standard errors further decrease.

Table 5: Staggered Diff-in-Diff - Country × Year fixed effects

Variables	(I) Liquid Assets (share DST)	(II) Loans to Banks ln(milUS$)	(III) Deposits from Banks ln(milUS$)	(IV) Private loans ln(milUS$)
$Submarine$	-0.0340	0.434**	0.727**	0.345***
$\times$ $Weak\ Lender_{ict}$	(0.0327)	(0.173)	(0.298)	(0.131)
Bank FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Country-Year FE	Yes	Yes	Yes	Yes
Obs.	3676	3467	2646	3671
Adj. R^2	0.514	0.839	0.739	0.914
M.D.V.	0.459	3.755	2.731	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)); 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.

The fourth part aims to isolate the credit supply channel. A key concern about the previous results is that demand, rather than supply, underpins the increase in loans provisions and the decrease in liquidity hoarding experienced by African banks. High-speed internet, once accessible, is beneficial for firms. Fast internet may contribute to rise firms productivity and their competitiveness. In that regard, the diffusion of fast internet can foster the demand of private loans, increase the opportunity cost for banks of hoarding liquid assets and increase the intensity of interbank transactions. Results from Table 5 contribute to weaken this alternative explanation. In this section, we provide further evidence consistent with a distinct credit supply effect due to financial technology adoption.

In order to isolate the effect of supply, we exploit the fact that some of the banks in our sample belong to banking groups operating in multiple countries. For those banks, it is possible that high-speed internet is available for the group as a whole, because one of the countries where the group has subsidiaries is reached by the new technology, but that the country where the bank is located is not connected. In that way, we have a source of exogenous variation, the arrival of high-speed internet in a country different from the one where the bank operates, immune to domestic demand factors.

Following the hints of the previous section, in Table 6 we report results from the staggered diff-in-diff specification where also the distinction between "weak" and "strong" lender is considered. Differently from the usual specification, here the variable $Submarine_{gt}$ (unique for each banking group) is a dummy that takes unit value if at least one country, among those where the group has subsidiaries, is connected to the fibre-optic cable. Table 6 presents a specification including only $Submarine_{gt}$ and bank and year fixed effects, while we also complement this specification by absorbing country-year and group-year fixed effects in Table 7. In both cases, our results are in line with the hypothesis that supply matters. When the banking group is subject to the technological shock, being reached by high-speed internet, banks in the group that before were weakly active on the interbank market: increase their amount of interbank transactions, reduce the hoarding of liquid assets and provide more credit to the private sector. The latter takes place regardless of the fact that the specific country where the bank operates is actually reached by fast internet.

Since demand-side effects are strongly alleviated in this setting, the above evidence suggests that the arrival of high-speed internet in Africa mostly affect banking infrastructure, particularly through the reduction of interbank transaction costs.

Table 6: Disentangling Supply and Demand

Variables	(I) Liquid Assets (share DST)	(II) Loans to Banks ln(milUS$)	(III) Deposits from Banks ln(milUS$)	(IV) Private loans ln(milUS$)
$Submarine_{gt}$	-0.0316	-0.104	0.209	0.136*
	(0.0215)	(0.120)	(0.147)	(0.0723)
$Submarine_{gt}$	-0.0730**	0.359***	0.623***	0.219**
$\times$ $Weak\ Lender_{ict}$	(0.0369)	(0.136)	(0.191)	(0.0928)
Bank FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Obs.	3720	3514	2710	3715
Adj. R^2	0.471	0.829	0.716	0.892
M.D.V.	0.461	3.750	2.696	4.933

Notes: This table reports estimates from a modified version of 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)); 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 for the group. This dummy takes value zero before the arrival of the cable and 1 from the time of the arrival on. Here, different from the main analysis, the variable submarine does not refer to the country where the bank operates but to the first country that was reached by the fibre-optic cable among the banks that are in the same group of the examined bank.; Submarine $\times$ 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 anticipated, Table 7 modifies the main specification to account for country-year fixed effects and group-year fixed effects. Country-year fixed effects are meant to absorb demand factors, whereas group-year fixed effects absorb within-group shocks. Estimated coefficients keep the same sign and increase in magnitude with respect to those in Table 6, but with an increase in the standard errors due to the large number of fixed effects included. However, our key findings are still supported by this specification. The findings on loans to banks and private loans remain positive and strongly significant.

Table 7: Disentangling Supply and Demand - Additional Fixed Effects

Variables	(I) Liquid Assets (share DST)	(II) Loans to Banks ln(milUS$)	(III) Deposits from Banks ln(milUS$)	(IV) Private loans ln(milUS$)
$Submarine_{gt}$	-0.0915	0.795**	0.700	0.830***
$\times$ $Weak\ Lender_{ict}$	(0.137)	(0.351)	(0.729)	(0.266)
Bank FE	Yes	Yes	Yes	Yes
Country-Year FE	Yes	Yes	Yes	Yes
Group-Year FE	Yes	Yes	Yes	Yes
Obs.	1382	1278	1048	1373
Adj. R^2	0.534	0.851	0.744	0.924
M.D.V.	0.440	3.818	2.872	4.989

Notes: This table reports estimates from a modified version of 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)); 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 $\times$ 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. Here, different from the main analysis, the variable Submarine does not refer to the country where the bank operates but to the first country that was reached by the fibre-optic cable among the banks that are in the same group of the examined bank. 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, country-year and group-year level. Standard errors in parentheses, clustered at bank level. ***, ** and * indicate significance at the 1%, 5% and 10% level, respectively.

3.3 Firms

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

We use data from the WB ES and focus on survey waves from 2006 to 2018, only considering African coastal countries. We exclude data prior to 2006 because of data harmonisation issues. 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 modified version 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 in equation (2) to provide a synthetic measure of the average causal effect of high-speed internet 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 are reported in Table 8. 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 Table 8 highlight a positive relationship between high-speed internet and firms activity. Being connected to the fibre-optic cable is associated to an easier access to finance, an increase in the probability that a firm gets a loan from commercial banks, an increase in total annual sales and, finally, to an increase in loans maturities.[19] Keeping on with our story, the arrival of fibre-optic submarine cables reduces transaction costs in the interbank market, reduces the hoarding of reserves and liquid assets, induces banks to reallocate funds towards the private sector and, as a result, it promotes business activities and growth.

Table 8: Staggered Diff-in-Diff - Firm's Finance and Sales

Variables	(I) Access Finance (dummy)	(II) Bank Credit (dummy)	(III) Sales ln(USD)	(IV) Maturity ln(Months)
$Submarine_{ct}$	0.150***	0.058	2.327	0.797***
	(0.040)	(0.049)	(1.650)	(0.245)
Country FE	Yes	Yes	Yes	No
Year FE	Yes	Yes	Yes	Yes
Obs.	25389	25222	24064	1139
Adj. R^2	0.0951	0.127	0.312	0.112
M.D.V.	0.638	0.211	12.11	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 the core heterogeneity at the country-level. 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 submarine

[19]The coefficient associated to total sales is particularly high in magnitude. We take this coefficient with caution and look for new and comparable data in order to corroborate our findings.

cable. In particular, countries that had underdeveloped interbank markets might benefit more from the technological shock 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). Table 9 presents the empirical results.

Results from Table 9 are in line with our hypothesis. The effect of submarine cables on corporate finance, sales and maturities is especially pronounced for firms in locations where the interbank market was not particularly developed prior to the arrival of fast internet.

Table 9: Staggered Diff-in-Diff - Weak Interbank

Variables	(I) Access Finance (dummy)	(II) Bank Credit (dummy)	(III) Sales ln(USD)	(IV) Maturity ln(Months)
$Submarine_{ct}$	0.043	-0.001	-0.168	0.587**
	(0.061)	(0.047)	(1.245)	(0.214)
$Submarine \times Weak\ Intb_{ct}$	0.160**	0.097**	3.821***	0.418*
	(0.065)	(0.035)	(1.315)	(0.238)
Country FE	Yes	Yes	Yes	No
Year FE	Yes	Yes	Yes	Yes
Obs.	25389	25222	24064	1139
Adj. R^2	0.0965	0.127	0.334	0.127
M.D.V.	0.638	0.211	12.11	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 country level. ***, ** and * indicate significance at the 1%, 5% and 10% level, respectively.

4 Robustness

In this section, we provide robustness checks supporting the main results. We divide the section into two subsections. The first refers to the estimates from the banking 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 staggered diff-in-diff specification as defined by equation (2).

First, we repeat the event study restricting the event window to be the interval [-3;+3] from the year of arrival of the submarine cable. Results are reported in Figure C1 of the Appendix. As we can see, our main findings remain stables. None of the dependent variables shows pre-trends. Indicators of interbank activity, loans to banks and deposits from banks, increase 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.

Second, we replace the indicator of weak lending as defined in equation (3). In Table D1 of the Appendix we define a within country measure of weak lender. The index takes value 1 if the bank was below the median of loans to banks, in the country, before the arrival of high-speed internet, and zero otherwise. Then, in Table D2 we create an indicator of weak borrower that takes value 1 if the bank was below the median of deposits from banks before the arrival of high-speed internet, and zero otherwise. Finally, in Table D3 we present the same estimates for weak borrower with the inclusion of country-year fixed effects. Results from these different specifications strongly corroborate the outcomes presented in the main text.

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 import 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 E1 of the Appendix. As we can see, estimates preserve the expected signs and remain statistically significant. We observe a slight reduction in magnitude but, overall, these findings support the intuitions presented in the main text.[20]

Fourth, we enlarge the dataset to span for a longer time period. We merge data from the Bankscope database with those provided by the new BankFocus by Bureau Van Dijk. 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 E2 of the Appendix.

Fifth, in order to deal with the 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. Then, we replicate the estimates from the main analysis. Results are reported in Table 10 below. Notwithstanding the relevant reduction in the number of observations, our results are qualitatively the same and quantitatively magnified, both in terms of magnitude and statistical significance.

Table 10: Staggered Diff-in-Diff - Restricted Sample

Variables	(I) Liquid Assets (share DST)	(II) Loans to Banks ln(milUS$)	(III) Deposits from Banks ln(milUS$)	(IV) Private loans ln(milUS$)
$Submarine_{ct}$	-0.114***	0.291**	0.743***	0.336***
	(0.0229)	(0.134)	(0.176)	(0.104)
Bank FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Obs.	1415	1415	1415	1415
Adj. R^2	0.618	0.865	0.769	0.939
M.D.V.	0.376	4.205	3.046	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)); 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.

[20]The inclusion of landlocked countries is important since it adds a pure control group in the staggered diff-in-diff design, thus alleviating the problem of negative weights (Borusyak and Jaravel (2017)).

Sixth, to alleviate the problem of missing values in a different way, we make data imputation and fill the gaps through the mice imputation function.[21] Results from our estimates are reported in Table E3 of the Appendix. As we can see, all our main results keep unchanged.

Seventh, we include country specific and bank specific control variables in our main specification. Appendix F is entirely devoted to this exercise. Table F1 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 reported in the main analysis: coefficients preserve their sign and statistical significance. Table F2 includes a proxy for the regulatory quality of the country: rule of law from the WB 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 F3 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 F4 deals with the contemporaneous inclusion of all the previous control variables.

Eighth, we replace bank fixed effects with country fixed effects, given that our treatment is at the country level. Results are reported in Table G1 of the Appendix. As we can see, country fixed effects generally reduce the significance of our estimates, without, however, altering the main outcomes. Proxies for the interbank market are positively related to the arrival of high-speed internet, whereas liquid assets are negatively related to it and private credit shows a positive coefficient.

Ninth, we test for different clustering of the errors. Results are provided in Appendix H. Table H1 shows the results when we cluster at the city level. Table H2 reports estimates when we cluster at the country level. Finally, Table H3 refers to the cluster 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.

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

4.2 Firms

All the robustness that we provide in this section apply to the staggered 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 are reported in Tables 11 and 12 below. Table 11 refers to the staggered diff-in-diff, whereas Table 12 refers to the specification with the "weak interbank" heterogeneity. As we can see, estimates are basically unaffected by the sample restriction. The effect of high-speed internet on firms activity is positive and significant. Being connected to the fibre-optic cables is associated to an easier access to finance, an increase in the probability that a firm gets a loan from commercial banks, an increase in total annual sales and, finally, to an increase in loans maturities.

Table 11: Staggered Diff-in-Diff - Firms Restricted Sample

Variables	(I) Access Finance (dummy)	(II) Bank Credit (dummy)	(III) Sales ln(USD)	(IV) Maturity ln(Months)
$Submarine_{ct}$	0.159***	0.134**	2.290	0.862***
	(0.0384)	(0.0530)	(1.780)	(0.273)
Country FE	Yes	Yes	Yes	No
Year FE	Yes	Yes	Yes	Yes
Obs.	20032	20032	19811	1010
Adj. R^2	0.0929	0.124	0.280	0.118
M.D.V.	0.635	0.240	12.16	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 12: Staggered Diff-in-Diff - Weak Interbank and Restricted Sample

	(I)	(II)	(III)	(IV)
Variables	Access Finance (dummy)	Bank Credit (dummy)	Sales ln(USD)	Maturity ln(Months)
$Submarine_{ct}$	0.0530	0.108	-0.063	0.635**
	(0.0603)	(0.0653)	(1.324)	(0.240)
$Submarine$	0.162**	0.0401	3.597***	0.427*
$\times\ Weak\ Intb_{ct}$	(0.0670)	(0.0510)	(1.229)	(0.245)
Country FE	Yes	Yes	Yes	No
Year FE	Yes	Yes	Yes	Yes
Obs.	20032	20032	19811	1010
Adj. R^2	0.0944	0.124	0.301	0.131
M.D.V.	0.635	0.240	12.16	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 I1 and I2 of the Appendix report the results. Estimates are in line with those presented in the main analysis. 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 I3 and I4 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 I5 and I6 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 combine country and bank reports with a machine-learning algorithm to build a dataset on a technology central for bank intermediation: the real-time gross settlement system (RTGS). This is combined with a comprehensive dataset on African banks and firms. We follow 489 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 arrival; 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 promotes the adoption of financial technology, which generates 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 becomes available.

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 can improve financial integration, risk-sharing and ultimately credit and development.

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Online Appendix

Appendix A

Our machine learning algorithm aims to predict the year from which a specific bank joins the RTGS system of its country. Our conceptual exercise seeks to solve the following problem:

$$Y_{ic} = f(X_c^1, X_{ct}^2, X_{ict}^3)$$

where: Y_{ic} represents the year of adoption of RTGS, for bank i, in country c; X_c^1 are variables at the country level. First, a dummy variable that indicates whether the country in which the bank operates is part of one of the following African economic unions: SADC, WAEMU and CEMAC. Second, the year of arrival of high-speed internet; X_{ct}^2 are two dummies that indicate the presence of RTGS and high-speed internet at the country level at time t; finally, X_{ict}^3 are a bunch of balance sheet variables that refer to bank i, in country c, at time t. In the specific, we use: total assets, operating profits, net loans, total equity, loans and advances to banks, deposits from banks, total exposure to central bank, returns on average assets (ROAA), and liquid assets over deposits and short-term funding.

We split the data into two sets: a train set, with 75% of the observations, and a test set, with 25% of the observations. Then, we develop several algorithms on the train set and we measure their performance on the test set. Below, we report the outcomes from the different methodologies.

First, we use the Elastic Net. Lasso and ridge methodologies use different criteria to shrink to zero uninformative predictors. Hence, it is generally difficult to choose between the two models. The Elastic Net algorithm solves this problem, selecting the best combination between lasso and ridge. To choose the optimal mix between these two, we use a cross-validation criterion based on the optimal alphas that minimize the overall error of the model. Our choice is alpha=1, a lasso model. Then, we use again cross-validation to choose the optimal shrinkage parameter, lambda. In this way, we obtain the significant predictors that the Elastic net method uses to compute the year of adoption of RTGS. The mean squared error (MSE) associated to the Elastic Net specification corresponds to 3.95.

Second, we use the Support Vector Machine. This tool was originally developed for classifying binary variables. It draws lines (kernel) in the variables space to assign observations to categories. The Support Vector Machine adopts a shrinkage parameter to deal with many predictors, and this shrinkage parameter depends on the kernel that is used. We test three types of kernels.

Linear. This kernel divides the space of the variables using lines. We use cross-validation to select the optimal shrinkage parameter. The mean squared error (MSE) associated to this model is 4.98.

Radial kernel. This kernel divides the space of the variables using radial lines. We use cross-validation to select the optimal shrinkage parameter. The mean squared error (MSE) associated to this model is 1.91.

Sigmoind kernel. This kernel divides the space of the variables using curves. We use cross-validation to select the optimal shrinkage parameter. The mean squared error (MSE) associated to this model is 4.89.

Third, we use Trees. Trees design logic diagrams to explain the predicted variables. They start dividing the observations according to the variable with the highest explicative power. Then, they carry on using the second, the third, and the other variables with the aim to improve the goodness of the prediction. Of course, this can generate over-fitting and useless splits. To counter this implicit drawback, we implement the cross-validation using several methodologies.

Random forest. In every node, it proposes a random subsample of the predictors for the split. We simulate several random forests to tune the optimal parameters. Then, we cross-validate several trees and find the optimal predictors. The mean squared error (MSE) associated to this model is 1.11.

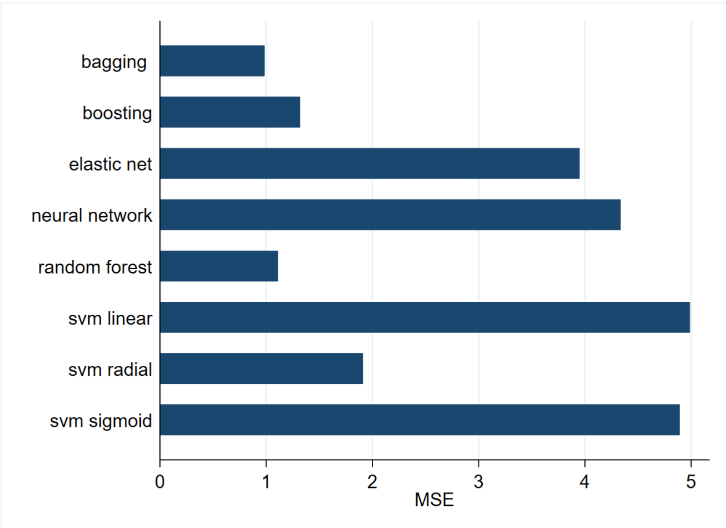
Bagging. It generates several bootstraps of the data and it explores all predictors in every node. Thus, each tree employs different observations to find the most predictive right-hand side variables. The mean squared error (MSE) associated to this model is 0.98.

Boosting. This algorithm is similar to bagging, however it weights the observations at each resampling according to the outcome of the previously trained tree. In particular, observations that are misclassified in the previous tree receive greater weights in the following tree. For this reason, we expect better performances coming from the boosting. We run several simulations to choose the optimal parameters. The mean squared error (MSE) associated to this model is 1.32.

Fourth, we use the Neural Network. This method does not deliver interpretable coefficients. However, it often provides the lowest errors. We run several simulations to tune the optimal parameters to our estimates. The mean squared error (MSE) associated to this model is 4.33.

Results from our previous analysis are outlined in Figure A1. Figure A21 summarizes each machine learning algorithm used to predict the year of adoption of RTGS, with their associated mean squared errors. As we can see from the figure, trees methodologies are the ones that minimize MSEs, in particular the bagging procedure.

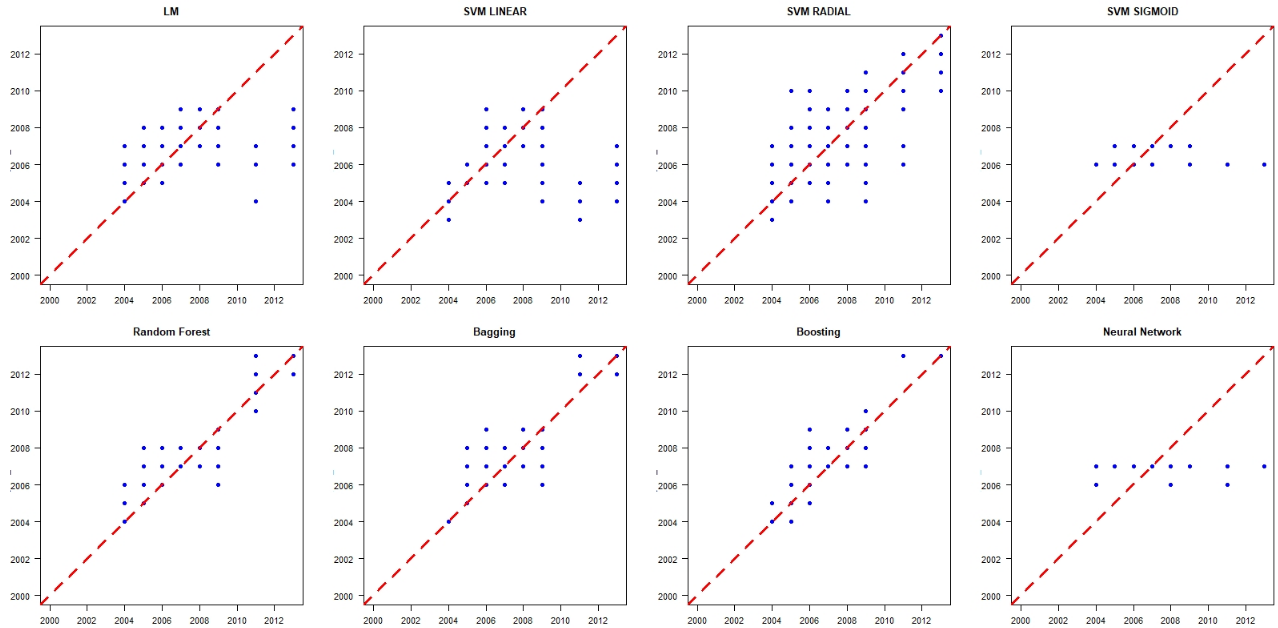
Figure A1: ML Algorithms and MSEs



Notes: The figure displays the MSEs associated to all the ML algorithms implemented to find the year of adoption of RTGS by banks.

We integrate the above findings with a graphical test that offers the comparison between the predictions from our ML algorithms and actual values of bank RTGS adoption. The latter graphical test is reported in Figure A2. Again, the bagging procedure is the one that shows less dispersion in the outcomes.

Figure A2: ML Algorithms and Dispersion



Notes: The figure displays, for all the ML models implemented in our analysis, the comparison between actual and predicted values. Actual values are on the x-axis. Predicted values are on the y-axis.

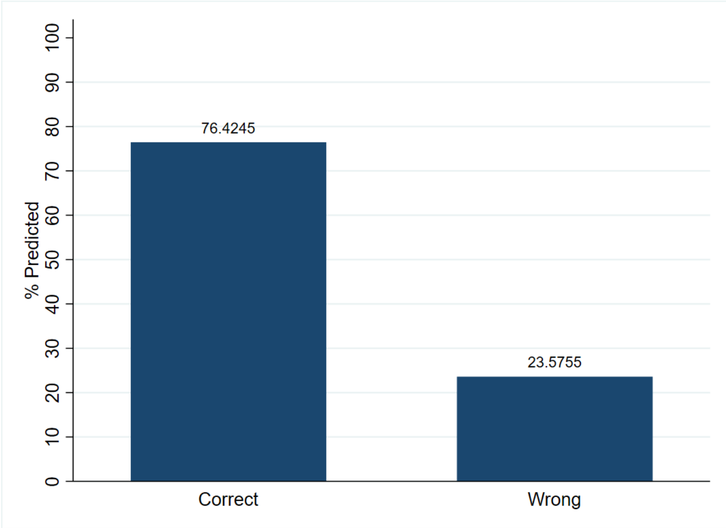
The combination of these two tests, mean squared errors and graphical comparison of the predicted values, indicates that the bagging delivers the most accurate results.

Focusing on bagging, we propose evidence of the soundness of our predictions.[22] Figure A3 reports the percentage of correct predictions in our sample. As we can see, 76% of the observations are correctly predicted, while the remaining 24% shows a very slight variation (with a MSE of 0.98).

To conclude, among the implemented machine learning algorithms, we choose bagging as our preferred specification. The dummy variable on bank RTGS adoption that we use in section 3.1, RTGS Version 2, is obtained from the bagging algorithm as explained in this Appendix.

[22]Notice that our bagging procedure, as all the ML algorithms that we have implemented, (possibly) provides different values of Y_{ic} for the same bank. That is due to the fact that we do not provide to the algorithm any identifier of the bank. To solve this issue, we decide to assign to each bank the lowest value of the year of RTGS adoption that the bagging predicts. Results in Table A2 and Figure A12 strongly support the goodness of our choice.

Figure A3: Bagging - Percentage of Correct Predictions



Notes: This figure displays the percentage of correct prediction from our preferred ML algorithm (bagging). Notice that 76% of the predicted values are equal to their true counterparts ("Correct").

Appendix B

Table B1: African countries and first fibre-optic submarine cable

(I) Country	(II) Location	(III) Cable	(IV) 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	Coast		
Kenya	Coast	TEAMS	jul 2009
Lesotho	Landlocked		
Liberia	Coast	ACE	dec 2012
Libya	Coast	ITALY-LIBYA	1998

Table B1 (continued): African countries and first fibre-optic submarine cables

(I) Country	(II) Location	(III) Cable	(IV) 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		

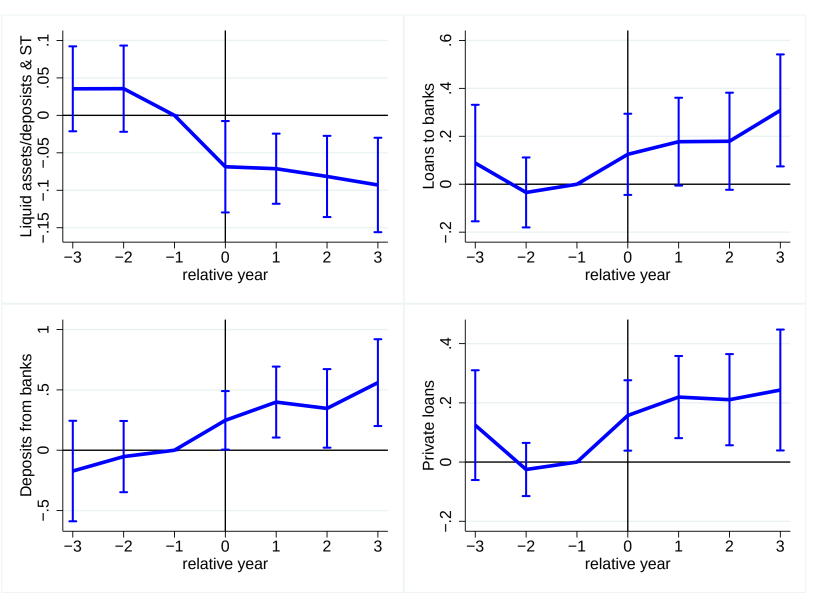
Notes: This table provides information about countries that are included in our sample. In particular, it shows the qualification of the country (coastal or landlocked), the first fiber-optic submarine cable landing on its coast (with its name), and the month and year when this cable was ready to service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

Appendix C

C1 Event study with a different event window

Figure C1 reports an event study similar to the one provided in the main text. Dependent variables are: loans to banks, deposits from banks, 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 submarine cable. As we can see, our findings remain stables. None of the dependent variables shows pre-trends. Indicators of interbank activity, loans to banks and deposits from banks, increase with the arrival of high-speed internet. The hoarding of liquid assets decreases after the technological shock. Finally, credit to the private sector increases in a significant way.

Figure C1: Event Study - 3 years 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 bottom left, Liquidity over deposits and ST funding. Finally, on the bottom right there are private loans.

Appendix D

D1 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 D1 presents the results.

Table D1: Staggered Diff-in-Diff - Weak Lender (country)

Variables	(I) Liquid Assets (share DST)	(II) Loans to Banks ln(milUS$)	(III) Deposits from Banks ln(milUS$)	(IV) Private loans ln(milUS$)
$Submarine_{ct}$	-0.0886***	-0.0858	0.244	0.0608
	(0.0221)	(0.103)	(0.152)	(0.0855)
$Submarine$	-0.0289	0.540***	0.437*	0.218*
$\times$ $Weak\ Lender_{ict}$	(0.0368)	(0.166)	(0.237)	(0.131)
Bank FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Obs.	3720	3514	2710	3715
Adj. R^2	0.473	0.831	0.715	0.891
M.D.V.	0.461	3.750	2.696	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)); 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.

D2 Weak borrower

Similarly to the case of weak lender, here we propose 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 in the country. Table D2 presents the results.

Table D2: Staggered Diff-in-Diff - Weak Borrower

Variables	(I) Liquid Assets (share DST)	(II) Loans to Banks ln(milUS$)	(III) Deposits from Banks ln(milUS$)	(IV) Private loans ln(milUS$)
$Submarine_{ct}$	-0.0246	0.00476	0.0596	-0.0388
	(0.0262)	(0.131)	(0.164)	(0.105)
$Submarine$	-0.0974***	0.186	0.752***	0.285**
$\times$ $Weak\ Borrower_{ict}$	(0.0340)	(0.181)	(0.217)	(0.124)
Bank FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Obs.	3408	3202	2731	3385
Adj. R^2	0.433	0.829	0.720	0.896
M.D.V.	0.443	3.796	2.689	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)); 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.

D3 Weak borrower with country-year fixed effects

We analyse whether the findings from Table D2 are robust to the inclusion of country-year fixed effects. Results are reported in Table D3.[23]

Table D3: Staggered Diff-in-Diff - Weak Borrower, Additional Fixed Effects

Variables	(I) Liquid Assets (share DST)	(II) Loans to Banks ln(milUS$)	(III) Deposits from Banks ln(milUS$)	(IV) Private loans ln(milUS$)
Submarine	-0.0686**	0.102	0.726**	0.297**
$\times$ $Weak\ Borrower_{ict}$	(0.0342)	(0.225)	(0.307)	(0.137)
Bank FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Country-Year FE	Yes	Yes	Yes	Yes
Obs.	3363	3152	2668	3339
Adj. R^2	0.454	0.836	0.741	0.917
M.D.V.	0.440	3.799	2.721	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)); 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 $\times$ 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.

[23] This is the counterpart, for weak borrower, of Table 5 in the main text.

Appendix E

E1 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 E1.

Table E1: Staggered Diff-in-Diff - Landlocked countries

	(I)	(II)	(III)	(IV)
Variables	Liquid Assets (share DST)	Loans to Banks ln(milUS$)	Deposits from Banks ln(milUS$)	Private loans ln(milUS$)
$Submarine_{ct}$	-0.0808***	0.158*	0.362***	0.109*
	(0.0199)	(0.0891)	(0.126)	(0.0633)
Bank FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Obs.	4983	4615	3519	4978
Adj. R^2	0.422	0.809	0.696	0.892
M.D.V.	0.458	3.565	2.535	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)); 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.

E2 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 by Bureau Van Dijk. Results are reported in Table E2.

Table E2: Staggered Diff-in-Diff - Updated Sample

	(I)	(II)	(III)	(IV)
Variables	Liquid Assets (share DST)	Loans to Banks ln(milUS$)	Deposits from Banks ln(milUS$)	Private loans ln(milUS$)
$Submarine_{ct}$	-0.0874***	0.194**	0.455***	0.181**
	(0.0197)	(0.0949)	(0.147)	(0.0809)
Bank FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Obs.	5389	5077	4029	5379
Adj. R^2	0.364	0.763	0.663	0.864
M.D.V.	0.444	3.820	2.860	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)); 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.

E3 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 E3.

Table E3: Staggered Diff-in-Diff - Imputed Sample

Variables	(I) Liquid Assets (share DST)	(II) Loans to Banks ln(milUS$)	(III) Deposits from Banks ln(milUS$)	(IV) Private loans ln(milUS$)
$Submarine_{ct}$	-0.110***	0.135	0.330**	0.149**
	(0.0263)	(0.0868)	(0.128)	(0.0682)
Bank FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Obs.	3879	3832	3442	3860
Adj. R^2	0.422	0.811	0.637	0.881
M.D.V.	0.475	3.699	2.511	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)); 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 F

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

F1 Country specific controls

Table F1 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 F1: Staggered Diff-in-Diff - Country controls

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

F2 Regulatory quality control

Table F2 includes a proxy for the regulatory quality of the country: rule of law from the WB 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 F2: Staggered Diff-in-Diff - Regulatory controls

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

F3 Bank specific controls

Table F3 introduces bank level characteristics to control for the size of the bank, its amount of total assets and the deposits it gathers.

Table F3: Staggered Diff-in-Diff - Bank controls

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

F4 All controls

Finally, Table F4 deals with the contemporaneous inclusion of all the previous control variables, both at the country and at the bank level.

Table F4: Staggered Diff-in-Diff - All controls

Variables	(I) Liquid Assets (share DST)	(II) Loans to Banks ln(milUS$)	(III) Deposits from Banks ln(milUS$)	(IV) Private loans ln(milUS$)
$Submarine_{ct}$	-0.0820***	0.130	0.431***	0.0921
	(0.0227)	(0.0992)	(0.130)	(0.0682)
Controls:				
Country indicators	Yes	Yes	Yes	Yes
Regulatory quality	Yes	Yes	Yes	Yes
Bank indicators	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Obs.	3538	3244	2561	3512
Adj. R^2	0.425	0.835	0.730	0.913
M.D.V.	0.458	3.788	2.702	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)); 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 G

G1 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 G1.

Table G1: Staggered Diff-in-Diff Country Fixed Effects

	(I)	(II)	(III)	(IV)
Variables	Liquid Assets (share DST)	Loans to Banks ln(milUS$)	Deposits from Banks ln(milUS$)	Private loans ln(milUS$)
$Submarine_{ct}$	-0.0965***	0.195*	0.353**	0.198**
	(0.0226)	(0.0999)	(0.147)	(0.0901)
Country FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Obs.	3861	3565	2794	3845
Adj. R^2	0.166	0.392	0.324	0.449
M.D.V.	0.466	3.735	2.675	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)); 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 H

Appendix H provides three different tables where we cluster standard errors by: city, country, and country-year.

H1 Clusters city

Table H1 shows the results when we cluster standard errors at the city level.

Table H1: Staggered Diff-in-Diff - Cluster city

Variables	(I) Liquid Assets (share DST)	(II) Loans to Banks ln(milUS$)	(III) Deposits from Banks ln(milUS$)	(IV) Private loans ln(milUS$)
$Submarine_{ct}$	-0.0966***	0.135	0.413**	0.147
	(0.0311)	(0.109)	(0.189)	(0.129)
Bank FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Obs.	3831	3530	2748	3813
Adj. R^2	0.430	0.829	0.715	0.892
M.D.V.	0.463	3.747	2.692	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)); 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.

H2 Clusters country

Table H2 reports estimates when we cluster standard errors at the country level.

Table H2: Staggered Diff-in-Diff - Cluster country

Variables	(I) Liquid Assets (share DST)	(II) Loans to Banks ln(milUS$)	(III) Deposits from Banks ln(milUS$)	(IV) Private loans ln(milUS$)
$Submarine_{ct}$	-0.0961***	0.139	0.411**	0.157
	(0.0336)	(0.115)	(0.197)	(0.140)
Bank FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Obs.	3837	3536	2754	3821
Adj. R^2	0.430	0.828	0.715	0.891
M.D.V.	0.463	3.744	2.690	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)); 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.

H3 Clusters country-year

Finally, Table H3 shows results when the cluster of standard errors is at the country-year level.

Table H3: Staggered Diff-in-Diff - Cluster country-year

Variables	(I) Liquid Assets (share DST)	(II) Loans to Banks ln(milUS$)	(III) Deposits from Banks ln(milUS$)	(IV) Private loans ln(milUS$)
$Submarine_{ct}$	-0.0961***	0.139*	0.411***	0.157*
	(0.0236)	(0.0744)	(0.124)	(0.0810)
Bank FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Obs.	3837	3536	2754	3821
Adj. R^2	0.430	0.828	0.715	0.891
M.D.V.	0.463	3.744	2.690	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)); 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 I

Appendix I collects all the robustness checks implemented on our sample of firms.

Each of the robustness applies to both the staggered 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 with the weak interbank interaction.

I1-I2 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 I1 and I2 report the associated results.

Table I1: Staggered Diff-in-Diff - Firms, Country controls

Variables	(I) Access Finance (dummy)	(II) Bank Credit (dummy)	(III) Sales ln(USD)	(IV) Maturity ln(Months)
$Submarine_{ct}$	0.112	0.101	2.456	0.122
	(0.0876)	(0.0836)	(1.786)	(0.280)
Controls:				
Country indicators	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	No
Year FE	Yes	Yes	Yes	Yes
Obs.	22696	22550	21867	1139
Adj. R^2	0.0911	0.124	0.329	0.171
M.D.V.	0.625	0.211	12.16	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 I2: Staggered Diff-in-Diff - Weak Interbank, Country controls

Variables	(I) Access Finance (dummy)	(II) Bank Credit (dummy)	(III) Sales ln(USD)	(IV) Maturity ln(Months)
$Submarine_{ct}$	-0.203	-0.0517	-0.075	-0.289
	(0.120)	(0.0935)	(1.656)	(0.289)
$Submarine$	0.279***	0.196***	3.305**	0.629**
$\times\ Weak\ Intb_{ct}$	(0.0770)	(0.0587)	(1.557)	(0.242)
Controls:				
Country indicators	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	No
Year FE	Yes	Yes	Yes	Yes
Obs.	22696	22550	21867	1139
Adj. R^2	0.0937	0.126	0.343	0.193
M.D.V.	0.625	0.211	12.16	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. 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.

I3-I4 Clusters survey

We cluster the errors by survey. Results are provided in Tables I3 and I4.

Table I3: Staggered Diff-in-Diff - Firms, Cluster survey

Variables	(I) Access Finance (dummy)	(II) Bank Credit (dummy)	(III) Sales ln(USD)	(IV) Maturity ln(Months)
$Submarine_{ct}$	0.150***	0.0580	2.327**	0.797***
	(0.0294)	(0.0354)	(1.169)	(0.245)
Country FE	Yes	Yes	Yes	No
Year FE	Yes	Yes	Yes	Yes
Obs.	25389	25222	24064	1139
Adj. R^2	0.0951	0.127	0.312	0.112
M.D.V.	0.638	0.211	12.11	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 I4: Staggered Diff-in-Diff - Weak Interbank, Cluster survey

Variables	(I) Access Finance (dummy)	(II) Bank Credit (dummy)	(III) Sales ln(USD)	(IV) Maturity ln(Months)
$Submarine_{ct}$	0.0437	-0.00197	-0.168	0.587**
	(0.0436)	(0.0338)	(0.881)	(0.214)
$Submarine$	0.160***	0.0977***	3.821***	0.418*
$\times$ $Weak\ Intb_{ct}$	(0.0460)	(0.0256)	(0.922)	(0.238)
Country FE	Yes	Yes	Yes	No
Year FE	Yes	Yes	Yes	Yes
Obs.	25389	25222	24064	1139
Adj. R^2	0.0965	0.127	0.334	0.127
M.D.V.	0.638	0.211	12.11	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.

I5-I6 Regressions with firms inputs

We use firms inputs as our dependent variables. Workforce, is the number of full-time employees in the firm; Electricity, is the total annual cost of electricity; and Raw materials, is the total annual cost of raw material. Estimates are reported in Tables I5 and I6.

Table I5: Staggered Diff-in-Diff - Firm's Inputs

	(I)	(II)	(III)
Variables	Workforce ln(N)	Electricty ln(USD)	Raw Materials ln(USD)
$Submarine_{ct}$	0.0763	2.491	3.524**
	(0.155)	(1.766)	(1.631)
Country FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Obs.	12637	23668	12536
Adj. R^2	0.129	0.343	0.398
M.D.V.	3.198	7.669	10.79

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 I6: Staggered Diff-in-Diff - Inputs, Weak Interbank

	(I)	(II)	(III)
Variables	Workforce ln(N)	Electricty ln(USD)	Raw Materials ln(USD)
$Submarine_{ct}$	-0.231	0.541	1.783
	(0.202)	(1.439)	(1.610)
$Submarine$	0.356**	3.097*	2.599
$\times\ Weak\ Intb_{ct}$	(0.148)	(1.566)	(1.705)
Country FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Obs.	12637	23763	12554
Adj. R^2	0.129	0.371	0.406
M.D.V.	3.198	7.696	10.80

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.