Essays in Development, Banking and Organisations

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Declaration

I certify that the thesis I have presented for examination for the PhD degree of the London School of Economics and Political Science is solely my own work other than where I have clearly indicated that it is the work of others (in which case the extent of any work carried out jointly by me and any other person is clearly identied in it). The copyright of this thesis rests with the author. Quotation from it is permitted, provided that full acknowledgment is made. This thesis may not be reproduced without my prior written consent. I warrant that this authorization does not, to the best of my belief, infringe the rights of any third party. I declare that my thesis consists of 43,062 words.

Statement of Conjoint Work

I confirm that Chapter 1 was jointly co-authored with Ali M. Choudhary (Director of the Research Department at the State Bank of Pakistan). I contributed 90% of the work. I confirm that Chapters 2 and 3 were jointly co-authored with Francesco Strobbe (Senior Economist, Finance & Markets Global Practice). I contributed 90% of the work.

Statement of use of third party for editorial help

I can confirm that Chapter 1 of my thesis was copy edited for conventions of language, spelling and grammar by Emma Hoyle. Chapters 2, 3 and 4 were copy edited for conventions of language, spelling and grammar by Rachel Lumpkin.

Acknowledgment

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Abstract

This thesis contains four chapters that participate to the literature between development economics, banking and organisational economics.

The first chapter shows that deposit volatility and costly bank liquidity increase the long-term lending rates offered by banks, which reduce loan maturities, long-term investment and output. Together with my co-author (Ali Choudhary from the State Bank of Pakistan), we formalise this mechanism in a banking model and analyse exogenous variation in deposit volatility induced by a Sharia levy in Pakistan. Data from the credit registry and a firm-level survey show that deposit volatility and liquidity cost: 1) reduce loan maturities and lending rates; 2) leave loan amounts and total investment unchanged; 3) redirect investment from fixed assets towards working capital. A targeted liquidity program is quantified to generate yearly output gains between 0.042% and 0.205%.

The second chapter, with my co-author (Francesco Strobbe from the World Bank), focuses on the importance of liquidity regulation in absence of deposit insurance and credible safe-asset commitment by banks. We show that bank liquidity regulation creates a commitment device on repaying depositors in bad states, which can: 1) stimulate a deposit inflow, moderating the limited liability inefficiency; 2) promote bank profits and branching, if deposit growth exceeds the intermediation margin decline. Our empirical test exploits an unexpected policy change, which fostered the liquid assets of Ethiopian banks by 25\% in 2011. Exploiting the cross-sectional heterogeneity in bank size and bank-level databases, we find an increase in deposits, loans and branches, with no decline in profits.

The third chapter focuses on the role of financial regulation, starting from the observation that it can create a demand for government bonds, generating government revenue gains. Together with my co-author (Francesco Strobbe from the World Bank), we study an Ethiopian banking regulation introduced in 2011, forcing banks to purchase a negative-yield government bond. High-frequency bank data and public finances documentation allow tracking the subsequent government revenue gain. This policy is compared to three alternatives: raising funds competitively on international markets; distorting the state-owned bank lending; and raising deposits through state-owned bank branches. Our results suggest that the revenue gain is moderate (1.5–2.6% of tax revenue); banks amass more bonds; their profitability slows without turning negative (from 10% to 2%).

In the fourth chapter I study the impact of World Bank managers on project success through the value-added method. Manager effects are interpretable as performance indices and are more volatile than country effects. Both correlate positively with determinants of productivity (i.e., schooling and institutions respectively) and provide evidence of a negative assortative matching, with high-performing managers assigned to low-performing countries. Exploiting a novel variation for World Bank board access, I find a significant manager premium for countries in the board. All of these results are consistent with the World Bank behaving as a planner which assigns its managers as project inputs to client countries.

Content

Chapter 1 - Deposit Volatility, Liquidity and Long-Term Investment: Evidence from a Natural Experiment in Pakistan*

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1 Introduction

In his work on industrialization and development, Alexander Gerschenkron (1962) emphasized the importance of banks in promoting long-term investment and technology adoption. His remark was triggered by a particular financial innovation: the provision of long-term finance by banks, which emerged toward the end of the 19th century and quickly gained popularity. Despite general agreement on the connection between long-term finance and development (for example World Bank (2015)), low-income countries (LICs) today exhibit an endemic presence of loans with short maturities (see Figure 1).

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We develop a novel explanation for the lack of long-term finance in LICs based on bank intermediation and the role of deposit volatility. Our mechanism is illustrated through a banking model and tested in Pakistan, exploiting exogenous variation in deposit volatility on the universe of corporate loans and a firm-level investment survey. Given this specific context, we refer to the discount rate as the liquidity cost paid by banks.

The mechanism relies on the maturity-transformation of banks, which convert short-term deposits into long-term loans. We highlight that volatile deposits and a high discount rate affect disproportionately the bank cost of supplying long-term loans because of a liquidity risk. The interaction between the cost of central bank liquidity and deposit volatility is key, because it creates a non-convexity in bank funding costs. For instance, small stochastic deposit withdrawals are covered by the bank with its liquidity at no extra cost, whereas large withdrawals force borrowing from the central bank at a premium rate. As a result, the equilibrium spread between the long- and short-term lending rate increases in the interaction between deposit volatility and the discount rate, leading firms to lower loan maturities, long-term investment and output.

A unique natural experiment provides exogenous variation in deposit volatility. Zakat is a recurring contribution that Muslims are expected to donate to the poor. In Pakistan, such Sharia-compliant obligation is directly managed by the government, in the form of a yearly 2.5% levy on bank deposits exceeding a wealth threshold. Three features of this obligation are central in creating deposit volatility. First, the timing of the levy. This is applied on only those deposits held in banks on the first day of every Ramadan. Therefore individuals can avoid the levy by withdrawing before the payment date and re-depositing afterwards. Second, the value of the threshold. Sharia law defines the wealth threshold as the price of 612.32 grams (52 tolas) of silver, and Pakistani authorities announce it only 48–72 hours before collection. Third, the deposit levy generates a notch. Individuals below the threshold enjoy a zero levy, while those with 1 Rupee above the threshold pay 2.5% on the overall amount - not just the part exceeding the threshold. As a result, individuals slightly above the threshold have large gains from engaging in withdrawal-and-redeposits than individuals further away from it. As a result of these unique features, the number of Zakat contributors fluctuates directly with the silver price, and the sharp discontinuities in timing and threshold generate extensive withdrawals and redeposits in a short period (between 4 and 6 months).

Our identification exploits the volatility of silver price in the quarter before Zakat as a source of exogenous variation for deposit volatility. If the price of silver is constant in the quarter before Ramadan, then the deposit drop is predictable. However, the higher silver price volatility, the wider is the range of possible realizations that the final drop can take. This increases the expected costs of liquidity for banks, which are passed onto borrowers through higher lending rates. Our reduced-form evidence on deposit volatility combines the volatility in the international price of silver with two measures of bank exposure to Zakat. The first exploits the exemption of some religious groups from the levy and, hence, their lack of withdrawal-and-redeposit. By combining the geographic variation in the ATM network at bank level, with a religious map of Pakistan, we compute the share of ATMs in withdrawal-prone areas. The

second measure uses bank-level information about how close the average depositor lies to the threshold, the deposit ratio. These two sources lead to qualitatively analogous estimates, with larger magnitudes observed under the latter.

Beyond the natural experiment, a credible investigation of this mechanism requires the local availability of high-quality documentation regarding banks' balance sheets and a credit registry. Also in this respect, Pakistan is the ideal country because its central bank, the State Bank of Pakistan, has kept a detailed credit registry for a long period. This allows us to combine the natural experiment with the universe of corporate lending, resulting in more than one million loans between 2002 and 2010. Given that deposit volatility affects loan supply through higher funding costs, then we exploit variation within-bank-firm and across-banks to separate loan supply from demand, as pioneered by Khwaja and Mian (2005, 2008). Complementing these datasets with a detailed survey of firm investment permits to further analyse how changes in financial characteristics affect real variables.

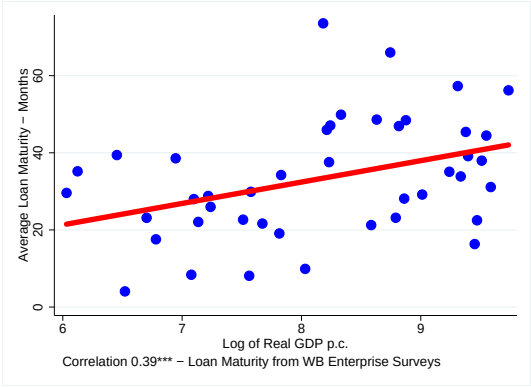
In the presence of a high silver price volatility and discount rate, we find a drop in loan maturities, which increases with the bank exposure to Zakat. In the same context, the average lending rate drops, in line with the predictions of our mechanism: as the long-term lending rate increases, firms switch from a "high-maturity–high-lending rate" product to a "low-maturity–low-lending rate" product. Finally, in terms of loan characteristics, we do not observe movements in the amounts borrowed. We further investigate the financing redirection and two margins are found to be key: 1) a long-to-short redirection, with a decline of loans with a maturity of 5 years or more, and an increase of those with a 1-year maturity; 2) a short-to-very short redirection, with an increase in loans with a maturity of 3 months or less, and loans that are originated-and-repaid before the levy. Beyond a rich series of robustness checks, we exploit another Islamic celebration, also based on the Lunar calendar (Eid Adha), as the ideal placebo for our test. This generates a similar decline in deposits due to religion, but without uncertainty on withdrawals generated by silver prices. As a result, we replicate our empirical strategy for this alternative period and cannot reject the null hypothesis of not statistically significant effects on maturities, rates or quantities.

To characterize how firms' investment responds to Zakat, we match a detailed firm-level survey with the loan-level data. This verifies that firms linked to banks that are more exposed to Zakat do not alter their overall investment amount, but change its composition with a decline in fixed capital investment and an increase in working capital. We subsequently quantify a policy counterfactual answering the following question: how would output respond if a targeted liquidity program neutralized the Zakat uncertainty on deposit volatility by temporarily lowering liquidity costs? In order to address this, we combine the theoretical model with the elasticities from the loan-level analysis. Our results state that the output gains of this policy lie between 0.042%, based on the ATM share estimates, and 0.205% on the deposit ratio ones.

Although the existence of this mechanism does not depend on the income level of a country, its extent and economic costs are likely to be more relevant in LICs for two reasons: their deposits are more volatile and their financial systems exhibit high discount rates or, often, non-

existent interbank markets and central bank liquidity facilities. For these reasons, although the results of our analysis are specific to Pakistan, this work offers three policy implications that extend beyond this context. First, monetary policy can promote a reallocation of maturities toward the short term through its liquidity operations and discount rate. Second, financial regulation moderating bank deposit volatility (i.e. deposit insurance, multiregional and multinational banking) can promote long-term finance and investment. Third, promoting financial institutions in LICs can lower long-term lending rates by allowing commercial banks to smooth deposit shocks. In particular, we argue that LICs central banks need to guarantee a stable, reliable and accessible source of liquidity to the banking system. This is rarely the case: we collect new data showing that more than 50% of African central banks do not provide stable liquidity.

Figure 1: Loan Maturities and Development



Notes: This figure shows a scatter plot between the average maturity of loans in months on the y-axis and the log of real GDP per capita on the x-axis. Data on the average loan maturity are from the World Bank Enterprise Surveys. Each dot is a country observation: the correlation is 0.39 and statistically different from zero at 1%. Data on log of the GDP per capita are in 2005 constant dollar from the Penn World Tables (Feenstra et al. (2015)).

This paper participates to three debates. First, it contributes to the literature on long-term finance and development by showing that bank funding costs can generate a redirection of loan maturities and firm investment toward the short term.[1] Second, this is the first paper to study a natural experiment on loan supply generated by a change in the second moment of a bank liability. Our contribution lies at the intersection of the literature on credit, that has focused on the first moment of bank liabilities[2], with an emerging literature focusing on depositor behaviour.[3] Third, it further examines the role of financial institutions in completing markets and the effect of monetary policy on real variables.[4]

In Section 2, we introduce our theoretical and empirical framework, identification and the main equations. In Section 3, we describe the data and present the main results, robustness

[1]This literature was pioneered by Levine (1997), Caprio Jr and Demirguc-Kunt (1998), Demirgüç-Kunt and Maksimovic (1998) and Diamond (2004), and more recently developed by Qian and Strahan (2007) and Bae and Goyal (2009).

[2]Paravisini (2008) studies how exogenous changes in government-to-bank loans affect the supply of credit, Schnabl (2012) investigates how bank-to-bank loans affect a variety of loan characteristics, while Khwaja and Mian (2008), Bustos et al. (2016) and Gilje et al. (2016) study how changes in the level of deposits affect credit, exploiting a variety of alternative identification strategies. Refer also to Iyer and Peydro (2011), Banerjee and Duflo (2014), Garicano and Steinwender (forthcoming).

[3]Refer to Iyer and Puri (2012), Iyer et al. (2016)

[4]For empirical references, for the former refer to Allen and Gale (2004), Allen et al. (2009), while for the latter to Bernanke and Gertler (1989), Bernanke and Blinder (1992), Kashyap and Stein (2000), Jiménez et al. (2012).

checks and placebo. Section 4 offers some remarks about the policy implications of our research and elements of external validity. Finally, we present conclusions in Section 5.

2 Theoretical and Empirical Framework

2.1 Theoretical Framework

We propose a three-period model with three agents: a household supplying short-term deposits to the bank, heterogeneous firms investing in short- and long-term projects, and a bank intermediating short-term deposits with short- and long-term loans. Short-term loans are given in period one and repay in period two, while long-term loans are given at one and repay at three. All prices are given, there is perfect competition and common knowledge.

Two forces are key. First, depositors withdraw a stochastic amount before the long-term loans are back and after the short-term loans are repaid. Second, the bank faces a non-convex cost of accessing the central bank facility for alternative liquidity: if the withdrawal is small, the bank covers it with its liquidity, and the additional cost is zero; if the withdrawal is large, it needs to borrow from the central bank at a positive rate, r_{CB}. This allows the second moment of the deposit withdrawal to have an impact, even in a risk-neutral model. The main result of this model is that the long-term lending rate increases with the volatility of bank deposits and the discount rate. The interaction of these two parameters is key: the higher the volatility in periods of high discount rate, the higher is the expected additional cost of funding, which pushes up the long-term lending rate. This encourages the marginal firm to give up a long-term project and a long-term loan, to reallocate toward a short-term project and loan, which lowers output.

In the interest of tractability, our model only presents two maturities (short and long), while in a more general model there would exist a continuum. The literature has shown, that with a multi-period environment and a more general setting, similar results are achieved if deposit volatility is persistent over time, for example Cox et al. (1985). We present the key elements of the model below and report in Appendix A its solution and details.

Household A representative household supplies unit deposits to the bank between periods 1 and 2 and periods 2 and 3, hence $D_{1,2} = D_{2,3} = 1$. In the morning of $t = 2$, the household collects the interests on the old deposits, $r_{D1,2}$. In the evening, it observes a realization of a shock ε and can consume more or withdraw some deposits, depending on whether ε is positive or negative. The second period deposits are described by $\widetilde{D}_{2,3} = 1+\varepsilon$, with ε being independent and identically distributed (i.i.d.) through a uniform, $\varepsilon \sim U[-v, v]$. The parameter v embeds the standard deviation of deposits, which we henceforth refer to as deposit volatility.

Firms There exists a unit continuum of firms, and each solves an investment allocation problem. Because of indivisibility, each firm i chooses to invest in either a short- or a long-term project. Both are *ex ante* observable: the short-term investment delivers a net return $p < 1$,

and the long-term project delivers a heterogeneous return ρ_i, uniformly distributed between 0 and 1, $\rho_i \sim U[0,1]$. Both are deterministic and known at the moment of the investment decision. Intuitively, ρ_i can be thought of as a draw of technology: some firms are endowed with a comparatively more productive technology in the long-term than in the short-term (their $\rho_i > p$), whereas others are endowed with a less productive long-term technology. Because of observability, the firm faces a differentiated market for borrowing. The short-term project can be funded with only a short-term loan $L_{1,2}$, taken out in period 1 and repaid in period 2 at a lending rate $r_{L1,2}$, and the long-term loan $L_{1,3}$ is repaid in period 3 at rate $r_{L1,3}$.[5] Each firms solves this problem and the aggregate demands for short and long-term lending emerge by aggregating over the continuum.

Bank At $t = 1$, the bank receives deposits, $D_{1,2}$, and allocates these into assets: short- and long-term loans $L_{1,2}$, $L_{1,3}$ and a liquid and safe asset $A_{1,2}$. In the morning of $t = 2$, the bank earns returns from short-term activities, hence $r_{L1,2}L_{1,2}$ and $r_A A_{1,2}$, and pays the household interests $r_{D1,2}D_{1,2}$, which are withdrawn. New deposits are supplied, $D_{2,3}$, and allocated into safe assets, $A_{2,3}$, and fund the long-term loans previously issued, $L_{1,3}$. In the final period $t = 3$, the bank's assets pay back $r_{L1,3}L_{1,3}$ and $r_A A_{2,3}$, respectively, and it reimburses the deposits and interests.

However, second-period deposits $D_{2,3}$ are subject to a shock ε after they are allocated into assets. If the shock is negative, then a withdrawal takes place. For a sufficiently small negative shock, the bank covers this with its liquidity, $A_{2,3}$; otherwise it accesses a refinance facility through the central bank and borrows the difference between the shock and $A_{2,3}$ at $r_{CB} > 0$, which is the premium on the cost of liquidity - the difference between the discount rate and the deposit rate. Therefore, in period 2 the bank is exposed to a liquidity constraint, $D_{2,3} - L_{1,3} > \varepsilon$, as in Prisman et al. (1986).

The loan supply and deposit demand for each period of the bank emerge by solving

$$\max_{D_{1,2},D_{2,3},L_{1,2},L_{1,3}} \left(r_{L1,2}L_{1,2} + r_A A_{1,2} - r_{D1,2}D_{1,2}\right) + \delta\left(r_{L1,3}L_{1,3} + r_A A_{2,3} - r_{D2,3}D_{2,3}\right) +$$

$$+\delta r_{CB} \int_{D_{2,3}-L_{1,3}}^{v} (D_{2,3} - L_{1,3} - \varepsilon) f(\varepsilon) d\varepsilon$$

in which $\delta \in (0,1]$ is the discount rate, and a balance sheet constraint applies in each period: respectively $L_{1,2} + L_{1,3} + A_{1,2} = D_{1,2}$ and $L_{1,3} + A_{2,3} = D_{2,3}$. These state that all liabilities of the bank (in this case only deposits) must equal the sum of the assets.

The first two terms of the maximand represent the profits in period 2 and 3, while the last term embeds the expected cost of borrowing from the central bank, simplified through the uniform distribution, $\frac{[v-(D_{2,3}-L_{1,3})]^2}{4v}$. If alternative liquidity is costless, so that the discount rate equals the deposit rate, $r_{CB} = 0$, then deposit volatility does not affect any rate.

[5] We explicitly leave out the possibility of firms financing a long-term project with a series of short-term loans, this is a reduced-form result of Hart and Moore (1994) and Milbradt and Oehmke (2015).

The equilibrium lending and deposit rates emerge through market clearing, by equating deposit and lending demands and supplies. Appendix A presents more details on each part of the model and the clearing; while Appendix B explores a few extensions.

Proposition *There exists a region for v and r_{CB}, such that an increase in deposit volatility, v, generates:*

** a change in loan characteristics, corresponding to: an increase in the long-term lending rate and a decrease in the average maturity of loans;*

** a change in the investment profile of firms, including: a decline in the long-term lending and investment share, and an increase in the short-term lending and investment share;*

** a resulting decline in overall output.*

All these effects on the role of deposit volatility increase with the discount rate. However, if the premium on the cost of liquidity is zero, so that $r_{CB} = 0$, then deposit volatility does not generate any effect on maturities or rates.

2.2 Empirical Framework

2.2.1 Exogenous Variation in Deposit Volatility

Zakat and Deposits Zakat is a poor-giving religious obligation and formalized in Sharia law. At the beginning of every Ramadan, individuals are expected to give a donate to the poorest to regenerate their own wealth. In most countries the Zakat payment is left to individual contributions, while in Malaysia, Saudi Arabia and Pakistan, the state directly collects and distributes such resources.

Pakistan presents the ideal setting for our study because of a unique collection system. In 1981 the Pakistani government introduced a mandatory Zakat payment to the state[6] and implemented it through a Sharia-compliant obligation in the form of a 2.5% levy on bank deposits that exceed a wealth threshold (Nisab-i-Zakat). This threshold, emanating from interpretations of the Sharia law, is calculated using the international price of silver and corresponds to the value of 612.32 grams (52 tolas). One central characteristic relative to the timing of this obligation plays a pivotal role: the threshold is announced by the State Bank of Pakistan and the Ministry of Religious Affairs only 2–3 days before the collection and management, and the obligation applies on only those deposits held in banks during the first day of Ramadan. The design of the levy creates a notch, because once a depositor lies above the threshold of 1 Rupee, the 2.5% applies to the whole deposit amount, implying a locally infinite marginal levy.

Despite the good cause, most Pakistanis avoid this altogether and give individual donations.[7] In fact, there is ample anecdotal evidence from newspapers that individuals rush to "withdraw and redeposit", so that bank deposits are substantially depleted in the weeks preceding the first

[6]Refer to the Zakat and Ushr Ordinance, 1980, available at http://www.zakat.gop.pk/system/files/zakatushr1980.pdf. For a historical review, refer to Nasr (2004).

[7]Refer to the work of the Charities Aid Foundation, World Giving Index 2015.

day of Ramadan and then more or less quickly return.[8] Sharia law directly links the threshold to the current price of silver, and in Appendix C we show a scatter plot between the threshold and the international price of silver per ounce in USD on the day of the announcement, which correlate 0.998.

In addition, four facts regarding the Zakat contribution in Pakistan are particularly useful for our research, because they facilitate our identification. First, Zakat is a mass phenomenon, and the threshold above which Zakat applies is low: the average amount of Nisab-i-Zakat over the 2002–2010 period corresponds to 25,856 Pakistani rupees (PKR), converted approximately into 250 USD. This is particularly low, given that in the same period the average GDP per capita lies at 2,595 USD, the average Pakistani deposit account contains 868 USD and on average 65% of deposit accounts exceed the threshold (see Appendix C). Second, silver price can be taken as exogenously determined to Pakistan, given that this country is among neither the world's top 20 producers nor the world's top 20 consumers of silver and that its first commodity trading platform begun offering silver futures only in mid 2011 (after the period in analysis in this paper).[9] Furthermore, as shown in Appendix C, the correlation between silver price and Pakistani GDP per capita growth as a measure of economic activity is low, negative and not statistically different from zero. Third, silver price is a particularly volatile commodity and Appendix C reports a few further descriptive statistics showing that: 1) silver is more volatile than gold, given that its market is much less liquid (result from the commodity literature); 2) there is no correlation between the mean price of silver and its volatility at quarter–year level and 3) silver price volatility increases with gold price volatility and declines with the volatility of economic variables (e.g. inflation, Fed funds rate, industrial production). Fourth, because Ramadan is based on a lunar calendar, its first day changes yearly and is progressively anticipated year by year from November 2002 to August 2010, as shown in Appendix C. This permits us to net out seasonality effects.

Zakat, the Price of Silver and Deposit Volatility Newspaper anecdotes suggest the existence of a withdrawal phenomenon prior to Ramadan and redeposit after the Zakat payment. This implies only a temporary depletion of the deposit stock in the six months around Zakat. In this section, we complement the previous elements with a statistical analysis to verify whether the following three hypothesis are met in the data:

1. the overall level of deposits does not change, there occurs only a temporary dip;

[8] In 2006 the *Dawn* newspaper had the headline "Heavy withdrawal to avoid Zakat cut" (available at http://www.dawn.com/news/211676/heavy-withdrawal-to-avoid-zakat-cut); in 2012 it had the headline "During Ramazan, Pakistanis dodge tax collectors" (available at http://www.dawn.com/news/742885/during-ramazan-pakistanis-dodge-tax-collectors) and in 2013 it had the headline "Clients rush to banks to avoid Zakat deduction" (available at http://www.dawn.com/news/1024075).

[9] See the statistics on silver for 2012–2014 provided by the United States Geological Survey, published by the United States Department of the Interior, available at http://minerals.usgs.gov/minerals/pubs/commodity/silver/mcs-2014-silve.pdf, and the World Silver Survey, 2015, issued by the Silver Institute, available at https://www.silverinstitute.org/site/publications/. Regarding the trading, the Pakistan Mercantile Exchange Limited is the first and only future commodity market in Pakistan, operating in Karachi. It begun activities 11 May 2007 and offered the first silver future contracts on the 31st May 2011, read more at http://www.pmex.com.pk/broker/documents/20-2011_-Listing_of_Silver_100_Ounces-3005-2011.pdf.

2. liquidity injections by the State Bank of Pakistan increase;

3. the volatility of deposits in the period before Zakat changes with the silver price volatility.

Unfortunately, we do not have access to high-frequency deposit data at bank-level: the highest available frequency is quarterly, which does not permit to study the rich within-quarter changes in temporary deposits. For this reason, in the interest of higher frequency, we investigate the previous points using aggregate country-level data in Pakistan and use data on the weekly amount of bank deposits and liquidity injections. These are only available for the years 2007-2014 and, therefore, in this section we restrict on this period. We define a variable, called Zakat 6-months, which takes unit value for the three months before and three months after payment of the Zakat. Table 1 indicates that, although the level of deposits does not change over the whole period, in column (1), banks acquire substantial liquidity injections by the State Bank of Pakistan, which increase by approximately 37%, in column (2). While it is possible that banks adjust also through other margins (e.g. holding more cash), this table shows that the liquidity offered by the central bank in this period is extensively used by banks.[10]

We further dissect the deposit behaviour in the following two ways. First, we show that deposits exhibit a temporary drop of -1.8% in the month of the payment of Zakat in column (3) of Table 1. Furthermore, column (4) highlights that this drop is lower when the price of silver is higher, a one standard deviation higher silver price, corresponds to a decline in the drop by 0.4% (as the threshold increases and less people are eligible to pay the levy). Furthermore, column (4) highlights that the second moment of silver does not affect the level of deposit withdrawals. Second, we study the deposit behaviour in every month within the Zakat period. For this purpose, instead of one dummy variable taking unit value across all periods, we replace every single month before and after with a set of separate dummy variables (hence six dummies and an omitted one). Figure 3 shows the average level of deposits when yearly trends and seasonality are netted out. Leaving out the fourth month before Zakat as the omitted category, we can see that around three months before Zakat a mild decline in deposits occurs, not statistically different from zero. This further drops two months before Ramadan and further drops to around -1.8% in the month of the Zakat payment. After this payment, there is a slow return of deposits back to trend, taking generally two to three months before the gap closes fully. Overall we can see that at Zakat, Pakistani banks lose roughly 1.8% of their deposits. Such magnitude should be considered as relevant, particularly because local banks rely mainly on deposits, which account on average for 75–80% of bank liabilities, as shown in Appendix D, and especially because the cost of this shortfall can be high, given that the central bank liquidity in this period is relatively expensive.

It is important to discuss the extent of the deposit drop. A 2.5% levy on a stock, such as deposits, should have been expected to generate much larger deposit-and-withdrawals. From anecdotal evidence, and Figure 3, we may infer the effect being mostly inframarginal, with a

[10] In order to understand the quantitative relevance of the Central Bank to address this liquidity need, we propose a simple calculation. Deposits decline on average by 1.8% for these months, this implies a shortfall of 79.5 Billion PKRs. In the same period, central bank injections go up by 37%, introducing 43.5 Billion PKRs. As a result, on average, the central bank covers 54.7% of the deposit shortfall.

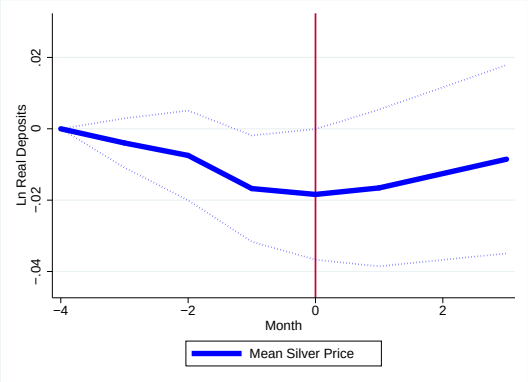
large number of relatively middle-income customers activating this phenomenon through small withdrawals around the threshold given the notch. To put things into perspective, in Appendix D we report data on the evolution of Zakat proceedings over time and find that Zakat collections are sizeable, comparable to 0.4% of Pakistan's tax revenues.

Table 1: Deposits, Liquidity and Zakat

Variables	(1) Bank Deposit Ln(PKRs)	(2) SBP Liquidity Injections Ln(PKRs)	(3) Bank Deposit Ln(PKRs)	(4) Bank Deposit Ln(PKRs)
Zakat 6-months	-0.00254	0.369**		
	(0.00297)	(0.158)		
Zakat 1-month			-0.0184***	-0.0188***
			(0.00277)	(0.00282)
Zakat 1-month				0.004***
$\times$ Silver μ_t				(0.002)
Zakat 1-month				0.0005
$\times$ Silver σ_t				(0.002)
Silver μ_t				0.028
				(0.033)
Silver σ_t				0.022
				(0.061)
Observations	392	392	392	392
Adj. R sq.	0.943	0.411	0.919	0.920
FE q, y	Yes	Yes	Yes	Yes
Mean Dep. Var.	15.30	11	15.30	15.30
S.D. Dep. Var.	0.0797	1.353	0.0797	0.0797

Notes: This table presents ordinary least-squares (OLS) estimates, where the unit of observation is weekly, and showing year and quarter fixed effects. The years analysed are 2007–2014. Robust standard errors are in parentheses. The dependent variables are the natural logarithm of the real bank deposits in billion of Pakistani rupees (PKR), in columns (1), (3) and (4) and the natural logarithm of the real liquidity injections by the State Bank of Pakistan (SBP) in million of PKR, in column (2). The Zakat 6-month is a dummy that takes unit value for the three months before and after payment of Zakat, for a total of six consecutive months. The Zakat 1-month take unit value for the month before the payment of the Zakat levy. The Silver μ_t and σ_t are respectively the standardized mean price of silver and volatility of silver over the whole period. Silver volatility is defined as the variation coefficient of the detrended silver price. The row "Adj. R sq." shows the adjusted R^2 of these regressions, and the next two rows show the mean and standard deviation (S.D.) of each dependent variable, respectively. ***, ** and * indicate significance at the 1%, 5% and 10% level, respectively.

Figure 3: Deposit Withdrawal and the Price of Silver



Notes: This figure reports a plot of OLS coefficients from a regression in which the natural logarithm of real deposits is regressed over a dummy for each month in the six-month period around Zakat, three months before and three months after. These results are obtained by interacting these dummies with the average price of silver over the whole Zakat periods in analysis. The fourth month before Zakat is the omitted category. Because Zakat payment changes every year according to the lunar calendar, the same regression also includes year and quarter fixed effects to net out year-specific trends and seasonality. The data are weekly between 2007 and 2014. Standard errors are robust and reported through the confidence interval of the coefficients.

Table 2: Deposit Volatility, Zakat and Silver

	(1)	(2)	(3)
Variables	Deposit Volatility	Deposit Volatility	Deposit Volatility
Zakat - 3-months	0.546	0.760*	0.665
	(0.396)	(0.424)	(0.423)
Zakat - 3-months		0.530**	0.581**
$\times$ Silver σ_t		(0.226)	(0.229)
Silver σ_t		-0.0423	-0.109
		(0.133)	(0.134)
Zakat - 3-months			0.283
$\times$ Silver μ_t			(0.271)
Silver μ_t			-0.421
			(0.276)
Observations	90	90	90
Adj. R sq.	0.013	0.061	0.068
FE q, y	Yes	Yes	Yes
Mean Dep. Var.	0	0	0
S.D. Dep. Var.	1	1	1

Notes: This table presents OLS estimates, where the unit of observation is monthly, and showing year and quarter fixed effects. The years analysed are 2007–2014. Robust standard errors are in parentheses. The variable Zakat 3-months is a dummy that takes unit value only for the three months before the payment of Zakat, this is also interacted with the monthly volatility in silver price, *Silver* σ_t and its mean *Silver* μ_t. The dependent variable represents deposit volatility, defined as the coefficient of variation of detrended monthly bank deposits. This has been standardized to take mean zero and unit standard deviation, the respective actual mean is 0.007 and standard deviation is 0.005. Also the silver price volatility variable has been standardized in order to simplify the interpretation of its coefficient. The row "Adj. R sq." shows the adjusted R^2 of these regressions, and the next two rows show the mean and standard deviation (S.D.) of each dependent variable, respectively. ***, ** and * indicate significance at the 1%, 5% and 10* level, respectively.

Finally we focus on the volatility of bank deposits and show that the volatility in the price of silver has an effect on the volatility of bank deposits in the period preceding Zakat. In order to calculate a variable describing deposit volatility, we go from a weekly analysis on the level, to a monthly analysis on the second moment. We calculate deposit volatility by detrending the

real deposit series, calculating the standard deviation of the detrended deposits over a month and dividing by the mean level of deposits in the corresponding month. This results in the coefficient of variation of deposits, which can be interpreted as the fluctuations in deposits as percentages of the mean.

We define a new dummy, Zakat 3-months, which takes unit value only for those three months. This is regressed over the volatility of bank deposits, including interactions both with silver price volatility and mean. Table 2 shows that during the three months before Zakat there is a general increase in volatility, by around half a standard deviation, and in particular this grows in the interaction between the Zakat dummy and silver price volatility: a one standard deviation increase in silver price volatility, during the three months before Zakat, generates an additional half standard deviation increase in deposit volatility. On the contrary, we do not find a significant effect for just the level of silver volatility outside Zakat or the level of silver in general. Overall, this section shows that the Zakat period exhibits a special deposit behaviour, with a temporary drop in deposits, a high usage of central bank liquidity and a deposit volatility increasing in silver price volatility. All these features are key for our identification, which we describe in detail in the next section.

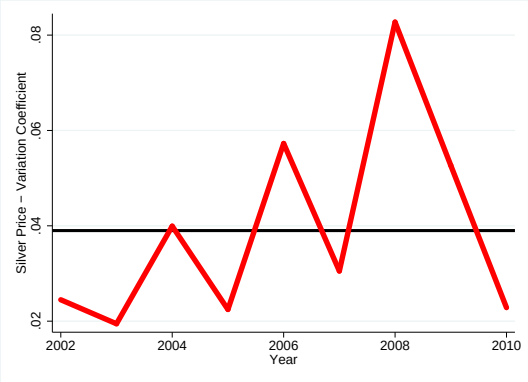
2.2.2 Identification

In this section we provide more specifics on our identification and present:

1. the time-series variation in silver-price volatility in the quarter before Zakat and the discount rate;

2. the cross-sectional variation in bank exposure to Zakat, describing in detail the ATM share and deposit ratio variables.

Figure 4: The Volatility of Silver Prices - 2002-2010



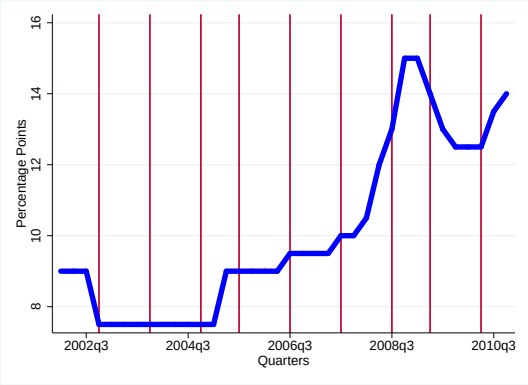
Notes: This figure reports the volatility in silver price in the quarter before the threshold announcement between 2002 and 2010. Silver price volatility is defined as the coefficient of variation, computed though the standard deviation of the detrended silver price for the quarter before Zakat, divided by the average silver price over the corresponding period. The average silver price volatility is 0.039, with a standard deviation of 0.021, a minimum of 0.019 and a maximum of 0.082. Figure C4 in Appendix C reports the same picture for all quarters between 1968 and 2015.

Time-Series Variation

Silver Price Volatility

In our identification, we exploit the volatility in the international price of silver as a source of exogenous variation for deposit volatility and Figure 4 reports the volatility in silver price in the quarter before the announcement. This shows that on average the volatility is relatively high, as fluctuations average 4% of the mean price, in a range between 2% and 8%. As discussed in Appendix C and D, silver price is highly volatile (more than gold, oil and copper), mainly because it is traded mostly for industrial use rather than store of value. As a result, the spikes in Figure 4 are mostly due to low-liquidity on international markets or periods of volatile silver demand. The sudden swings in this variable generate useful variation for our identification.

Figure 5: Discount Rate and Zakat



Notes: This figure reports the evolution of the discount rate set quarterly by the State Bank of Pakistan between 2002 and 2010. The vertical lines describe the quarters in which the payment of Zakat take place. The average discount rate in this period is 10.07 percent, with standard deviation 2.43, a minimum of 7.5 and a maximum of 15 percent.

Discount Rate and State Bank of Pakistan

Replacing deposits with central bank liquidity can be expensive in Pakistan. As shown in Figure 5, the average discount rate between 2002 and 2010 was 10%, between 7.5% and 15%. This generated a 5% average premium on liquidity, between 2.5 and 10 points above the deposit rate (5%, shown in Appendix R). The State Bank of Pakistan, as the local central bank, is responsible for the conduct of the monetary policy and defines the discount rate through its policy meetings, which in general take place at quarterly frequency. As highlighted by our model, this is a key variable because in combination with deposit volatility, it changes the intertemporal allocation of lending by commercial banks. As previously reported, there is ample evidence showing that the State Bank of Pakistan intervenes strongly to support banks' liquidity during Zakat. This is achieved through liquidity injections, which can be considered a quantity-response. However, the price-responses could be equally important, and indeed, how this rate is determined can impact our identification. We take into account this point in two ways. First, in line with Jiménez et al. (2012), we can claim that within a bank–borrower relationship, the discount rate can be considered to be a predetermined variable, particularly because we will absorb all other common shocks through time fixed effects and only exploit its interaction with a bank-specific deposit volatility measure. Second, the relatively small extent of the Zakat withdrawals are not enough to generate changes in monetary policy and, in fact, we cannot reject the null hypothesis of no discount rate adjustment during the Zakat period.

In this respect, Figure 5 shows the evolution of the discount rate over the sample period, between the first quarter of 2002 and the fourth quarter of 2010 and reports a vertical line for

the quarter that includes Zakat. It is difficult to verify the presence of a policy rate response to Zakat, and in Appendix E, Table E1, we regress the discount rate (that varies at quarter-year level) over a Zakat quarter dummy and cannot reject the null hypothesis of no rate change, even accounting for quarter or year fixed effects. Note that as Zakat changes quarters over time, due to the lunar calendar, we can control for seasonality and other recurring factors. The Zakat coefficient is not only insignificantly different from zero but also very small in magnitude.

Among several reasons behind this lack of rate adjustment, SBP may face a classical Tinbergen rule problem with one policy tool and too many objectives (Tinbergen (1952)). Consistently with this, in September 2009, the central bank explicitly mentioned this case in the minutes of its meetings:[11]

liquidity tightness [...] is mostly due to the month of Ramadan and Eid festival. Likely reversal of these phenomena [...] is expected to improve the market liquidity in the coming months. [...] Uncertainty regarding the outcome of ongoing fiscal consolidation, resolution of electricity problem, and timing of official foreign inflows call for prudence at this point. Therefore, there will be no change in the SBPs [State Bank of Pakistan's] policy rate, which will remain at 13 percent. These issues are likely to determine SBPs policy trajectory in the coming months.

It is particularly interesting to analyse this statement for two reasons. First, there is explicit recognition of the liquidity tightness as Ramadan approaches and the Zakat payment is due. This may be because 2009 was a particularly sensitive year for this problem: the discount rate was almost 1.5 standard deviations above the 10% mean, and the volatility in the price of silver was at its peak. Second, the statement directly reports the variables that are likely to be considered in its setting: inflation, output gap, fiscal consolidation, supply constraints (electricity) and foreign inflows. These are useful because they all point toward a multitude of objectives to be covered and, possibly, therefore to the fact that the monetary policy rate does not change because of the Zakat obligation.

Cross-Sectional Variation

The extent to which the Zakat contribution affects banks depends on how much banks are exposed to the withdrawal-and-redeposit. We measure this cross-sectional variation through the following two indicators: ATM Share, as the share of ATMs in Sunni-majority areas by each bank; Deposit Ratio, as the distance between the average bank deposits and the wealth threshold.

ATM Share

Pakistan is an Islamic republic, with 95% of its population professing Muslim faith and the remainder composed mostly of Christians, Hindus, Buddhists and Animists.[12] The majority of

[11] See page 2 of the Monetary Policy Statement, available at http://www.sbp.org.pk/m_policy/MPD-29-Sep-09(English).pdf

[12] Refer to the 1998 Census collected by the Pakistan Bureau of Statistics, aggregate information available at http://www.pbs.gov.pk/sites/default/files//tables/POPULATION%20BY%20RELIGION.pdf .

Muslim Pakistanis adhere to the Sunni school (76%), with the remaining 19% belonging to the Shia.[13]

This distinction plays an important role in our identification because the rules of Zakat payment are differentially applied to Sunni and Shia followers. Although both are subject to the Zakat principle, Sunni Pakistanis are obliged by law to pay through their bank accounts,[14] whereas Shia Pakistanis have been allowed to contribute their Zakat individually since the mid 1980s.[15] As a result, banks that are more exposed through their ATMs and branch network to Sunni-majority areas are also more exposed to the deposit drop. We focus on ATMs because they are generally present in larger bank branches, which are likely to be more involved in the management of large cash amounts.

For this reason, we mapped the number of ATM per city by every bank in each year between 2002 and 2010. This map has been superimposed onto the religious map of Pakistan produced by Dr M. Izady and the Columbia University Gulf/2000 project.[16] To measure the exposure to Sunni-majority areas by bank b in year y, we construct the index $Exposure_{by} = \sum_{c=1}^{N_{by}} w_c \times num_{bcy} / \sum_{c=1}^{N_{by}} num_{cby}$ in which we calculate a weighted sum of all ATMs in the numerator, where cities are given a different value depending on their religious composition, divided by the total number of ATMs. The weight assigned to each city, w_c, is coded from the religious map of Pakistan: Sunni-majority areas are assigned 1, Sunni–Shia or Sunni–Hindu mixed areas 0.5 and other areas 0 (mostly with Shia, Hindu or Christian majorities). This results in an index of exposure that varies at bank–year level for the 30 banks operating in Pakistan. Unfortunately, only the cross-sectional variation of this index is used, because the time-series change in this indicator is negligible (as shown in Appendix D). For this reason, rather than using a bank–year-level index, we take a bank average of this exposure over 2002–2014 and define it as $Exposure_b$.

Deposit Ratio

In this part we exploit another feature that changes the exposure of a bank to Zakat: the average amount deposited in the bank. *Ex ante*, banks with deposit accounts containing higher amounts are more exposed to Zakat because they will experience a greater outflow of funds. In fact, as depositors engage in withdrawal-and-redeposit operations to bunch below the Nisab-i-Zakat, banks with a higher average deposit amount will experience a larger withdrawal of funds.

[13] Derived from the map produced by Dr M. Izady and the Columbia University Gulf/2000 project. Refer to http://gulf2000.columbia.edu/images/maps/Pakistan_Religion_lg.png.

[14] The 1980 ordinance allows individuals of any *fiqh* (sub-practice within the Sunni and Shia traditions) to fill an exemption module. In principle, it would be possible also for Sunni Pakistanis to seek a Zakat exemption. However, this is rare, in some cases because of social stigma and lack of transparency from some banks. For example refer to Dawn, http://www.dawn.com/news/647723/zakat-exemption-limit-doubled.

[15] This exemption was discussed between 1982 and 1988 and implemented in the final correction of the law in 1989. Refer to Nasr (2004) for a historical and political account of these episodes.

[16] This map is available from http://gulf2000.columbia.edu/images/maps/Pakistan_Religion_lg.png and is based on a combination of historical data, census information and online documentation. To cross-validate the content of the map, we compared the aggregate numbers with the 1998 Census data collected by the Pakistan Bureau of Statistics and found that these sources are aligned. For more on this, refer to PBS.

For this reason, we exploit a feature of the Monetary Survey of Pakistani banks, collected by the State Bank of Pakistan, which requests all banks to state the amount contained in their average deposit account, and we define the following index of exposure $Exposure_{by} = {}^{Avg.Deposit_{by}}/_{Nisab-i-Zakat_y}$, in which the exposure of bank b to Zakat in year y is higher when the average amount deposited relative to the Nisab-i-Zakat threshold in year y is higher. Therefore, for a given year y and threshold, banks with a higher deposit amount are modelled to be more exposed to this phenomenon. This indicator has advantages and disadvantages. One advantage is its simplicity, based on one moment of the deposit account distribution and ease of interpretation. Another advantage is that it varies both across banks and within banks over time: this is not due to changes in the average deposit amount, which is time-invariant (see Appendix D), but to time-series changes in the threshold. A disadvantage is that it is based on only one moment of the distribution, and therefore, for extremely unequal distributions in deposit accounts, the indicator could be a poor measure of the intensity of this phenomenon. A further disadvantage is its availability, because it was measured between only 2005 and 2009.

2.3 Empirical Model

2.3.1 Loan Characteristics

We exploit the Zakat payment as a source of exogenous variation in the time-varying deposit volatility for bank b at time t, given the heterogeneous exposure of banks. Therefore we model Zakat as $Zakat_{bt} = Exposure_b \times Silver\ \sigma_t$, in which $Exposure_b$ measures the exposure of bank b to Zakat, which depends on the margin, and $Silver\ \sigma_t$ is the variation coefficient of the detrended international silver price during the quarter before the beginning of Ramadan, which is our reduced-form measure of deposit volatility.

Thus, equation (1) permits us to study how the characteristics of a loan given by bank b to firm f at time t change with respect to volatility. The term x_{bft} describes three characteristics for each loan: the maturity as natural logarithm of days, the interest rate on the loan (lending rate) and the natural logarithm of the amount in real 2010 PKR:

$$x_{bft} = \beta_1 Zakat_{bt} + \beta_2 Zakat_{bt} \times Rate_t + \eta_3 X_{1bt} + \iota_b + \iota_{bf} + \iota_{ft} + u_{bft} \tag{1}$$

such characteristics are regressed over the Zakat variable and its interaction with the discount rate at time t, $Rate_t$. The time dimension, denoted by t, is the quarter of a year. Controls are included at bank-time level, X_{1bt}, specifically: 1) the capital-to-asset ratio, as a measure of risk taking; 2) the return on asset, after tax, as a measure of bank profitability; 3) the ratio of government securities to total assets, to account for exposure to the Pakistani government and their possible liquidity effect; 4) the deposit share of liabilities, to measure the degree of reliance on deposit as a source of funding, and 5) the natural logarithm of the total assets in real PKR, as a measure of bank size. We also include a variety of fixed effects: 1) at bank level to remove bank time-invariant unobservable components; 2) a bank–firm fixed effect to account for the matching between borrowers and lenders; 3) a firm–year effect to remove firm–year-varying

shocks (e.g. changes in loan demand) and common shocks; 4) a bank–quarter fixed effect to remove seasonality on the conditions of loans offered by bank b in quarter q.

Equation (1) can be interpreted as a difference-in-difference estimation, in which the experiment takes place within a firm and across the banks interacting with the firm. This model exploits variation within the same firm obtaining loans in a given year by different banks, which are differentially exposed to the Zakat phenomenon. In so doing, we net out time shocks across all firm–bank matches, firm loan demand through firm–year shocks and seasonality at bank–quarter level, which leave available only the bank–quarter–year specific variation in loan supply. To simplify the interpretation of the coefficients in equation (1), we standardize the two main regressors ($Exposure_b$, $Silver\ \sigma_{ty}$), subtract from the discount rate its minimum value and divide by the standard deviation. As a result, β_1 can be interpreted as the change in the characteristic x_{bft} of a loan received by firm f from bank b in response to a one standard deviation increase in silver price volatility for a bank one standard deviation more exposed to Zakat, given that the discount rate is at its minimum value (7.5% in our sample). Correspondingly, β_2 adds to this the role of a one standard deviation increase in the discount rate.

Given that our treatment varies at bank–quarter–year level, we allow the residual of loan characteristics to be correlated within banks and quarter–year and cluster accordingly.

2.3.2 Investment Profile

Regarding the investment profile of firm f, only the yearly subscript y is used because the firm-level investment survey is defined at annual frequency. By matching for every firm all loans by all banks in every year, we are able to construct a measure of firm exposure to Zakat as follows:

1. We define $Loan\ Share_{fbt} = \sum_{q=1}^{Q_{f1y}} l_{fbt} / \sum_{b=1}^{N_b} \sum_{q=1}^{Q_{bfy}} l_{fbt}$ as an index of exposure of firm f to bank b by defining the fraction of loans received by firm f from bank b in time t (year y in this case) over the sum of all loans l_{fbt} received by firm f from bank b at time t divided by the sum of all loans received by all banks in the same year.

2. We define $Zakat_{ft} = \sum_{b=1}^{N_b} Loan\ Share_{fbt} \times Zakat_{bt}$ as the index of exposure of firm f to Zakat as the sum across all banks N_b connected to firm f of the product between the exposure of the firm to the bank, $Loan\ Share_{fbt}$, multiplied by the exposure of the main bank used by firm f to Zakat, $Zakat_{bt}$.

As a result, we can employ the index of firm exposure to Zakat. This studies how the investment profile of firm f in sector s in year y responds to volatility, in which k_{fsy} describes the overall rate of investment, the investment in fixed capital and working capital. Equation (2) is key to our estimation:

$$k_{fsy} = \gamma_1 Zakat_{fsy} + \gamma_2 Zakat_{fsy} \times Rate_y + \iota_f + \iota_s + \iota_{sy} + \iota_b + \iota_{bs} + \iota_{by} + \nu_{fsy} \qquad (2)$$

where the first two elements test the proposition. Because we are interested in removing possible demand-side effects, in this formulation we include in addition to firm and year fixed effects, sector and sector–year fixed effects. At the same time, because it may be possible that firms with a different number of banks experience different shocks, we also introduce a fixed effect for the number of banks, interacted with the year and the sector.

Note that this exercise, although being tied to the theoretical model, is not the ideal experiment. To perform the ideal exercise, we would need data about each single investment project considered by each firm at any point in time, which should be linked to the loan characteristics received, so that we could: 1) disentangle investment demand from finance supply and 2) verify that when financial products present worse conditions for the long term, firms either reduce or abandon long-term projects. Our test only provides an aggregate picture, which although imperfect is parallels to ideal experiment.

3 Data and Results

3.1 Data and Sample

Beyond the exogenous variation in deposit volatility, Pakistan presents high-quality statistical documentation that allows the investigation of our main hypothesis. We use a variety of databases to map the empirical analogues of our theoretical model, listed as follows.

1. The Corporate Credit Information Report and information on x_{bft}. This dataset contains the population of loans, which is part of the Electronic Credit Information Bureau held at the State Bank of Pakistan, and provides information on all loans given by all financial institutions to any corporate entities. This dataset includes specific information on the amount of each loan, the associated interest rate, the loan initial and end dates, information on collateralization, the sector of the borrowing firm, the nature of the facility and the type of financial product used by the bank. This information is available between 2002 and 2010.

2. Pakistan ATM Bank-Wise Network and information on $Exposure_b$. We build a map for every bank operating in Pakistan, which includes the ATM location in each city for every year. This information is collected by the State Bank of Pakistan in its annual statistical publication.[17] We digitize this information and construct a map that includes 467 cities all over Pakistan. We double-check the total number of ATMs per bank–year obtained from our map against the total number of ATMs as declared by each bank in their annual reports; the correlation between these numbers is 0.996, and Appendix D shows a scatter plot of the numbers.

3. The London Bullion Market Association silver price database and information on $Silver\sigma_t$. This contains daily prices for silver, and we focus on the variable "Silver Price per Ounce" in USD between 2002 and 2010 (1 ounce corresponds to 28.3495 grams). This is the resulting price of the auction that takes place every day at 12:00 noon London time.

4. State Bank of Pakistan Statistics and Monetary Surveys and information on r_{CBt}, X_{1bt} and $Exposure_b$. From the statistical archive of the Pakistan central bank, we extract three central pieces of information. First, the consumer price index at monthly frequency, which we use to make real and intertemporally comparable all variables in PKR. Second, the discount

[17] Reported in the publication under "Appedix-VII [*sic*] Bank Wise ATMs Location". For 2014, this can be found at http://www.sbp.org.pk/publications/anu_stats/2014/Appendices/APPendix-VII.pdf. Additional years can be accessed through the statistical web page of the Pakistan central bank.

rate, which is the rate at which the State Bank of Pakistan provides liquidity to banks. Third, the balance sheet of all banks at quarterly frequency, which we use to control for bank–time-varying characteristics and to obtain the measure of average deposits, used to calculate bank exposure to Zakat.

5. Investment Survey of Non-Financial Sector Firms. This is a statistical publication of the State Bank of Pakistan reporting information on fixed capital, working capital and total investment for more than 230 very large firms in 15 sectors between 2005 and 2010. These record average sales of 121 million USD and have access to alternative financial products (stocks, bonds). We are able to match this database with the loan-level data from banks and verify the investment profile predictions of the proposition. This exercise presents both a disadvantage and an advantage. On the one hand, having few firms is not ideal, because this limits the tests that we can produce. On the other hand, finding an effect on large firms, implies that we are underestimating the effect on the average firm. In fact, while firms in our sample enjoy a variety of alternatives to bank funding (internal capital market, stock issuance, bonds), which should confine this effect to zero; small firms have a restricted access to alternative funding and therefore are likely to bear this liquidity risk.

Sample from the Credit Information Bureau Data The Corporate Credit Information Report contains information on more than three million loans between 2002 and 2010 given to over 90,000 borrowers. Unfortunately, because of the inappropriate entry of some information by financial institutions, not all of these loans are available for our analysis. Specifically, we restrict our sample to those loans with no missing values or spelling mistakes for the loan maturity, the lending rate and the amount of the loan. This leads to a sample of 1,060,137 loans over the nine years 2002–2010 from 30 banks to 24,972 firms.[18]

As Table 3 shows, the average loan exhibits a maturity of 6.36 log points (corresponding to 578 days), an amount of 15.59 log real PKR (corresponding to 5.9 million PKR and 56,872 USD) and a lending rate of 13.43 points. In the next sections, we discuss the issue of sample selection and verify that the probability of belonging to our sample is uncorrelated with the Zakat variables. On average a firm receives 42.5 loans over the whole period and 4.7 loans per year. Several firms borrow from multiple banks, with 14.57% of all loans originated by a firm that borrows from at least two banks in the same quarter of the same year.

Concerning the cross-sectional variation of the Zakat variable, Panel B of Table 3 reports the two definitions of banks' exposure to Zakat: 1) the ATM share, which is time invariant and hence we have only one observation per bank, and 2) the Deposit Ratio, which varies per bank

[18] Choudhary and Jain (2014) provide rich and exhaustive details on the credit registry and the availability of data. In principle the universe contains 97,449 borrowers, composed by 11,395 classified as "corporates" and 86,053 classified as "consumers and sole proprietors", which they exploit almost entirely given their focus on loan size. Because our predictions require a sample in which three variables are available (maturity, lending rate and amount), this leads to a smaller sample containing only 25.62% of overall borrowers. These include all 11,395 classified as "corporates" and 13,577 classified as "consumers and sole proprietors". In particular within this last group are mostly included individual liability firms, "sole proprietors", given that on average they receive large and frequent loans. In discussing the results of our estimates, we verify that the inclusion of a loan in our sample is not correlated with our Zakat variable.

over time and we observe it for six years, which provides 175 data points. Panel C reports time-series information on the variables used in our estimation: the discount rate and silver prices, reporting summary statistics both over its volatility and mean price. Both of these variables vary at quarter-year level. Panel D reports the summary statistics for the bank-level controls. Finally, Panel E reports summary statistics on the outcome for the firm-level analysis (total investment, fixed assets and working capital), with all these variables defined as the growth in firm assets (respectively, total, fixed and working capital) net of depreciation. The sales variable expresses the size of these firms: these are big firms, with average sales of 121 million USD, with large cross-sectional heterogeneity. For example, oil and mining companies are among the largest firms (e.g. Pakistan State Oil Company and Shell Pakistan).

Table 3: Summary Statistics

	(1)	(2)	(3)	(4)	(5)
Variables	Observations	Mean	St. Deviation	Minimum	Maximum
Panel A - Corporate Credit Information Report					
Loan Maturity in Ln Days	1,060,137	6.36	0.87	3.33	9.07
Lending Rate	1,060,137	13.43	3.95	5	45
Loan Amount in Ln PKR	1,060,137	15.59	2.26	4.26	24.06
Panel B - Bank Exposure to Zakat					
ATM Share	30	0.41	0.20	0	0.54
Deposit Ratio	175	4.24	6.54	0	36.2
Panel C - Discount Rate and Silver					
Rate	36	10.07	2.43	7.5	15
Silver Price σ	36	0.039	0.019	0.016	0.090
Silver Price μ	36	10.86	5.40	4.47	26.41
Panel D - Bank-Level Controls					
Capital to Assets	1,080	0.106	0.747	0.037	4.205
ROA	1,080	0.004	0.028	-0.160	0.102
GVT Bonds to Assets	1,080	0.173	0.127	0.038	0.665
Deposit to Liabilities	1,080	0.727	0.236	0.004	0.971
Ln Tot. Assets	1,080	10.70	1.75	6.64	13.68
Panel E - Firm-Level Outcome and Sales					
Total Investment	642	-0.013	0.189	-0.427	0.917
Fixed Capital	642	0.002	0.245	-0.580	1.336
Working Capital	642	-0.042	0.285	-0.838	0.872
Log of Sales	642	0.319	1.088	0.1	15.511

Notes: This table reports the number of observations, mean, standard deviation, minimum and maximum values for the main variables in this analysis from the most important databases. Panel A shows information from the Corporate Credit Information Report on: the maturity of loans in the natural logarithm of days (the mean corresponds to 578 days), the lending rate and the amount of the real loan in the natural logarithm of 2010 PKR. Panel B shows information on the bank exposures to Zakat as defined in Section 3.3.1. The ATM share summarizes the share of ATMs held in Sunni-majority areas. The second index of

exposure is given by Deposit Ratio, measured as the ratio between the average deposit of a bank and the Nisab-i-Zakat. Panel C shows summary statistics for the discount rate, as defined by the quarterly meeting of the Pakistan central bank and silver price. The first row reports the coefficient of variation of silver and the mean of silver and the unit of observation is the quarter of a year. The coefficient of variation is calculated by dividing the standard deviation of the detrended silver price at quarter-year level by the average silver price in the same quarter-year cell. Panel D shows summary statistics from the monetary surveys, reporting bank-level variables on the 30 banks analysed for every quarter of every of the nine years between 2002 and 2010. Capital to assets measures the ratio between the bank equity and size of the balance sheet, ROA is the after-tax return on assets, GVT Bonds to Assets is the exposure to government bonds through a ratio of the federal government securities holding over total assets, Deposit to Liabilities is the share of liabilities funded through deposits and Total Assets is the size of a bank's balance sheet. Panel E reports the summary statistics on the outcome variables and the sales variable for 237 firms belonging to the sample. Total investment is defined as the growth rate in firm assets net of depreciation, fixed investment as the growth rate in fixed assets net of depreciation and working capital as the growth rate in working capital. The sales variable is expressed through the natural logarithm of its real 2010 thousand PKR value.

3.2 Main Results

3.2.1 Loan Characteristics

The main results of this section are listed in Table 4, we report the bank exposure through the ATM share in columns 1-3, while through the deposit ratio in columns 4-6 . The first term in the table represents the effect of a one standard deviation increase in silver price volatility, for banks with a one standard deviation higher exposure, when the discount rate lies at its minimum rate (7.5%). The second term adds on the previous the effect of a one standard deviation increase in the discount rate.

The first term highlights that even when the discount rate is low, banks pass the expected cost of deposit volatility on creditors. The row $Zakat_{bt}$ shows that in these cases creditors keep the same maturity for their loan, but accept the higher lending rate (30 basis points in column 2 and 70 basis point in 5) without changing loan sizes.

However, when central bank liquidity is more expensive, the equilibrium loan changes along both the average maturity and size. Column 1 and 2 indicates that banks that are one standard deviation more exposed through the ATM share, in presence of a one standard deviation higher silver volatility and discount rate, give loans with maturities shorter by 2% (approximately 12 days) and with lower rates 13 basis points. Analogously, columns 4 and 5 indicate a decline in maturities of 14.4% (corresponding to 83 days) and lending rate by 70 basis points. In both cases the amounts borrowed do not change.

Both the ATM share and deposit ratio show that the discount rate is a key variable in this context. For this reason we unpack the effects presented in Table 4, by reporting two sets of pictures in Appendix F, which show the evolution of the elasticity of loan maturities, lending rates and loan amounts to the discount rate. Figure F1 reports these for the ATM share exposure, Figure F2 reports these for the deposit ratio and both report the linear predictions of the effect, as emerging from Table 4. In Appendix G, we show the same picture, but replace the discount rate variable with a dummy for every quartile of the discount rate to catch non-linearities. In both cases, the results are close in terms of magnitudes and implications: a large part of the effects observed in Table 4 takes place in the presence of a high discount rate, with the rate ranging between 12% and 15% (recorded during 25% of the sample). For lower values of this rate, the effects are not statistically different from zero. This is consistent with

our theoretical model: if the premium on liquidity is zero, r_{CB}, then deposit volatility has no effects on lending.

Table 4: Zakat and Loan Characteristics - Bank Controls

	(1)	(2)	(3)	(4)	(5)	(6)
Variables	Maturity	Lending	Loan	Maturity	Lending	Loan
	Ln(Days)	Rate	Ln(PKRs)	Ln(Days)	Rate	Ln(PKRs)
$Zakat_{bt}$	0.034	0.296**	-0.008	0.090	0.711**	-0.138
	(0.022)	(0.121)	(0.027)	(0.069)	(0.305)	(0.243)
$Zakat_{bt} \times Rate_t$	-0.023**	-0.132**	-0.001	-0.144**	-0.692**	-0.020
	(0.010)	(0.052)	(0.013)	(0.055)	(0.313)	(0.185)
Exposure	ATM	ATM	ATM	Deposit	Deposit	Deposit
	Share	Share	Share	Ratio	Ratio	Ratio
Observations	1,060,137	1,060,137	1,060,137	662,744	662,744	662,744
Adj. R sq.	0.784	0.708	0.889	0.734	0.688	0.890
Mean Dep. Var.	6.363	13.43	15.64	6.363	13.43	15.64
S.D. Dep. Var.	0.868	3.956	2.260	0.868	3.956	2.260

Notes: This table reports OLS estimates of equation (1); the unit of observation is a loan received by firm f by bank b at time t (quarter q of year y). Fixed effects are included for firm, firm–year, bank–firm, bank–quarter and quarter–year, as reported in the third-last row FE. Standard errors are clustered at bank–time level; the number of clusters is 816 in Panel A and 383 in Panel B. Maturity in Days Ln measures the maturity of a loan through the natural logarithm of its number of days between the origination of the loan and the contracted end date. Lending Rate reports the interest rate applied by the bank to the firm on the loan. Real Loan Amount Ln measures the natural logarithm of the amount of the loan in real 2010 PKR. These variables are regressed on the following: 1) $Zakat_{bt}$ is a variable composed by the interaction of the standardized exposure of bank b and the standardized variation coefficient of silver price in the three months preceding the first day of Ramadan; 2) the interaction between $Zakat_{bt}$ and $Rate_t$, multiplies the $Zakat_{bt}$ variable with the discount rate as applied by the central bank on liquidity loans to private banks. Such policy rate is modified as follows: we subtract the minimum value, 7.5%, and divide by the standard deviation 2.43%. In this way, the coefficient on $Zakat_{bt}$ can be interpreted as the effect of a one standard deviation increase in silver price volatility for banks that are one standard deviation more exposed to Zakat, in the minimum rate (7.5%). The interaction can be interpreted as the additional effect on the previous effect of a one standard deviation increase in the discount rate. Panel A reports the bank exposure to Zakat through the ATM Share using the standardized share of branches in Sunni-majority cities. Panel B reports the bank exposure to Zakat through the deposit ratio using the standardized ratio between the average deposit account for bank b divided by the wealth threshold, Nisab-i-Zakat, for the year. The bank-level controls reported here vary at the t level and are the Capital to Assets ratio, the ROA (return on assets), the government bonds to total assets ratio, the deposit share of liabilities, and the natural logarithm of total real assets. The number of Observations and Adjusted R^2 (Adj. R sq.) of each regression is reported in each panel. For the ATM share exposure, we can use the full sample with 1,060,137; for the deposit ratio, we observe this variable between only 2005 and 2009, which includes only 662,744 loans. The Mean and Standard Deviation (S.D.) of the dependent variables are reported in the last two rows of the table, respectively. ***, ** and * indicate significance at the 1%, 5% and 10% level, respectively.

The two sources of cross-sectional variation deliver conceptually similar results, with large quantitative differences. This is due to a Local Average Treatment Effect, LATE, interpretation, given the different margins exploited by each identification. In fact, the exposure to Zakat through ATM share compares banks heterogeneously exposed to Sunni versus non-Sunni. In this case the control group is composed by banks with a low exposure to individuals with a positive probability of withdrawal. Conversely, the deposit ratio exposure provides a measure on the intensity of the withdrawals around the wealth threshold. In principle this control group may not necessarily coincide with one described by the ATM share, which explains the difference in our estimates. Given the nature of the Zakat phenomenon, it is plausible to expect the deposit ratio to be larger than the ATM share, considering that 76% of Pakistanis belong to the Sunni branch and are subject to the Zakat regulation: in the case of the ATM share

we cannot distinguish between compliers (Sunni who withdraw) and non-compliers (Sunni who do not withdraw), while through the deposit ratio variable we have a more refined measure of compliers (but fewer observations).

A variety of concerns could affect our estimates, and in the appendices we carefully address these. First, in the current setting we introduce only bank–time controls, whereas in Appendix H we complement the results of Table 4 by offering alternative combinations of controls: excluding all controls; introducing loan-level controls; focusing on bank–time *per se* and interacted with the discount rate; and finally introducing loan-level, bank-level and interactions with the discount rate. This does not affect our results. Second, the Zakat payment can have both an effect on banks uncertainty over a very high deposit withdrawal (the core of this paper), but also through the temporary decline in deposits (level effect). We address this in the following three ways: first, we always control for the level of deposits measured at quarterly frequency in the regressions (normalized by the share of assets); second, we take care of the expected deposit decline using bank-quarter fixed effects and third, in Appendix I, we add to the main specifications a control for the interaction between the exposure to Zakat and the mean price of silver in the three months before Zakat and their interaction with the discount rate. As shown in Tables 1 and 2, because the first moment of silver has an effect on the first moment of deposits, while the second moment of silver has an effect on the second moment of deposits, we can use our reduced-form also to account for the level effect. Third, because it may be argued that silver price volatility could correlate with a variety of macroeconomic factors, in Appendix J we replicate the results of Table 4 and add to the main specification an alternative in which we multiply the bank exposures to Zakat (and also its term with the discount rate) with the following macroeconomic controls: 1) GDP per capita; 2) GDP per capita growth; 3) Inflation; 4) Exchange Rate; 5) Foreign Direct Investment capital inflows (FDI) and 6) all the previous controls together. Although some changes in the point estimates are observed, the results are qualitatively unchanged. Fourth, our sample includes the recent financial crisis, during which global assets and commodities experienced important fluctuations. In Appendix K, we replicate the results of Table 4 by excluding the months from December 2007 to June 2009, described as recession months by the Business Cycle Dating Committee of the National Bureau of Economic Research. Because this period generated extensive fluctuations in global stocks, bonds and commodities, we show that our results do not rely exclusively on this phenomenon. Fifth, in Appendix L we discuss the results of Bertrand et al. (2004) and Cameron et al. (2012) within our empirical framework and offer a variety of alternative computations of our standard errors; although in some cases some results become significant around 10%, the main findings are unaffected. Sixth, in Appendix M we replicate the results of Table 4 by adopting two alternative measures of silver price volatility: 1) we define volatility as the standard deviation of the daily growth rate in silver price during the quarter before Zakat and 2) we derive measures of expected silver price volatility from option prices, using the Black–Scholes model, for the quarter before Zakat. Despite the alternative methods of calculating volatility, the results are in line with Table 4, given that these measures are highly correlated as shown in Table M1. Seventh, in

Appendix N we extend our results to a two-month window and a four-month window, showing that our findings are mostly unaffected. Eighth, as clarified in Section 4.1, we extract from the universe of Pakistani corporate lending (roughly three million loans) a sub-sample containing loans that record a maturity in days, a lending rate and a size in PKR. Because of reporting mistakes by banks, some loans are unable to be used: from missing one or more key variables, to reporting no borrower or bank code, to obvious typing errors (i.e. maturities with missing or invalid numbers). In Appendix O we show that this measurement error is uncorrelated with our Zakat variables: this is achieved by regressing a dummy variable taking unit value when a loan is included in our sample and zero otherwise on the Zakat variables. We find that the probability of belonging to the sample does not correlate with Zakat.

Finally, in Appendix P we offer some further test showing that the results of our mechanism are heterogeneous across different firms. In Table Q1 we show that firms with a larger lending volume tend to be less affected, though the magnitudes are quite small: only firms that are between 5 and 10 standard deviations above the mean are immune to volatility. On the contrary we see that firms taking more loans, but not necessarily larger loans, are not differentially affected. In Table Q2, we show that firms with a higher share of collateralization are comparatively less affected, but once again with small magnitudes; while the presence of a rating does not heterogeneously affect the results.

3.2.2 Additional Evidence

In this section we provide evidence on three additional predictions of the model. First, we explore the reaction of the *agreed* lending rates at different maturities in presence of deposit volatility and a high discount rate. We verify that the lending rates on longer-term loans (with a maturity exceeding 4 and 5 years) increase more than those with a short maturity and the share of such loans declines in presence of higher volatility and cost of liquidity. Second, we show that also among loans with short-maturities (less than one year), there is a reallocation toward loans with a maturity of three months or less and loans that are given and repaid before Zakat. Third, consistently with the model, we cannot reject a positive, yet imprecise, effect of Zakat on deposit rates.

For the first point, we present two tests:

1. A replication of equation (1), in which we run the same regression with the following changes: a) replace the discount rate with one dummy per quartile; b) introduce a dummy for each maturity class of loans (one year or less, two years, three years, four years, or five years or more) and interact these with our Zakat variables.

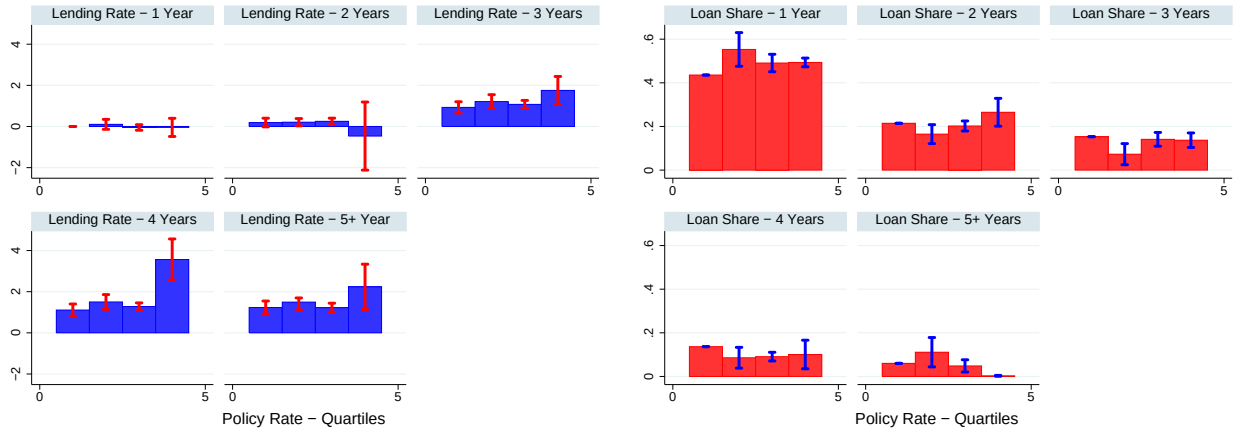
2. An equation at bank level, in which we observe at every t the share of loans given by each bank in every maturity class, which are regressed on the variables as in equation (1).

We use these results to quantify the output effect of Zakat in Section 5.

Figure 6 shows that the lending rates of loans with a maturity of one year or less and two years do not respond to an increase in deposit volatility and bank exposure for any value of the discount rate, which is in line with our theoretical model. However, the lending rates of loans

with a maturity of three, four, or five years or more all increase by around 2.5 points in presence of a one standard deviation in silver price volatility and bank exposure to Zakat. Nonetheless, such increases are registered for a discount rate only in the fourth quartile, which corresponds to a rate between 13 and 15 percentage points. The left panel of Figure 6 reports a similar exercise, in which we aggregate the loans at bank–quarter level to verify how the distribution of disbursed loans reacts to changes in deposit volatility and discount rate. Analogously to the previous picture, we can see two key results: 1) at the fourth quartile of the discount rate there is a disappearance of loans with a maturity of five years or more and 2) there is a corresponding increase in loans given at maturity of one year or less and two years. Therefore, this bank-level characteristic confirms our findings. This is not a fully comprehensive test: in this section we can see how *agreed* long-term rates respond to deposit volatility and a high discount rate and we are aware that selection could take place in either direction. However, we believe that these results are consistent with our mechanism.

Figure 6: Zakat, Lending Rate and Loan Shares



Notes: This figure reports estimates of the effect of different quartiles of the discount rate on the lending rate of loans of different maturities (left panel) and the share of loans given by banks (right panel). In the left panel each box reports a maturity class: the top-left corner reports loans with a maturity of one year or less, the top-centre reports loans with a maturity of two years, top-right reports those of three years, bottom-left reports those of four years and bottom-centre reports those of five years or more. Within each box the first column reports the effect of the first quartile of the discount rate, the second the effect of the second, and so on. A significant difference in lending rates takes place only when the discount rate is in its fourth quartile, in that case both loans with a maturity of three, four and five years see a significant increase in their lending rate. The right panel reports an analogous picture, but with data at bank level, showing the distribution of loan share across loan maturities. Note that in presence of a discount rate in the fourth quartile, loans with a maturity of five years or more disappear and there is a corresponding statistically significant increase in loans with a maturity of two years and one year or less.

Second, we verify the behaviour of very short-term loans by looking at the changes of maturities for loans that are shorter than one year. For this reason two variables are defined: "Maturity 3 Months or Less" takes unit value if a loan has a maturity of less than 90 days and "Loan Given and Repaid before Zakat" taking unit value if a loan is originated and repaid before the Zakat period. These are a small fractions of overall loans 3.8% and 0.4% respectively and for this reason we cannot exploit the same level of variation applied in equation (1). Therefore while we still employ the Zakat variation, along the ATM share and deposit ratio exposures, we only introduce bank, firm and time fixed effects. The results, presented in Table 5 are consistent with the hypothesis of a reallocation of toward very short-term loans. A one standard deviation increase in silver price volatility and discount rate leads banks one standard deviation more exposed to give loans with a maturity of 3 months or less by 0.23%, along the

ATM share exposure, and 4.05%, along the deposit ratio one. Finally, there occurs also an increase in the probability of loans given and repaid before Zakat: a one standard deviation increase in silver volatility, leads more exposed banks to increase the probability of giving such short loans by 0.42% under the ATM share exposure and 0.62% under the deposit ratio. These effects are increasing when the discount rate increases, but are not precisely estimated. Finally, in Appendix P we show through a time-series analysis of the average monthly deposit rate in Pakistan, that during Zakat there seems to be positive effect on deposit rate, as predicted by the theoretical model and highlighted in Appendix A. Though the point estimate is positive, we are unable to reject an hypothesis that this change is not statistically different from zero.

Table 5: Zakat and Short-Term Loans

	(1)	(2)	(3)	(4)
Variables	Maturity 3 Months or Less	Loan Given and Repaid before Zakat	Maturity 3 Months or Less	Loan Given and Repaid before Zakat
$Zakat_{bt}$	0.0006	0.0042*	0.0139	0.0062**
	(0.0022)	(0.0022)	(0.0240)	(0.0025)
$Zakat_{bt} \times Rate_t$	0.0023*	0.0020	0.0405*	0.0033
	(0.0010)	(0.0012)	(0.0211)	(0.0024)
Exposure	ATM Share	ATM Share	Deposit Ratio	Deposit Ratio
Observations	1,060,137	1,060,137	662,744	662,744
Adj. R sq.	0.369	0.317	0.398	0.277
FE b, f, t	Yes	Yes	Yes	Yes
Mean Dep. Var.	0.038	0.004	0.038	0.004
S.D. Dep. Var.	0.191	0.064	0.191	0.064

Notes: This table reports OLS estimates; the unit of observation at loan level and reports the characteristics of a loan received by firm f by bank b at time t (quarter q of year y). Fixed effects are included for firm, bank and quarter–year, as reported in the third-last row FE. Standard errors are clustered at bank–time level; the number of clusters is 816 in Panel A and 383 in Panel B. "Maturity 3 Months or Less" reports a dummy variable taking unit value for all loans with a maturity lower than 3 months, while "Loan Given and Repaid before Zakat" takes unit value for all loans that are given and repaid before the payment of the Zakat obligation.These variables are regressed on the following: 1) $Zakat_{bt}$ is a variable composed by the interaction of the standardized exposure of bank b and the standardized variation coefficient of silver price in the three months preceding the first day of Ramadan; 2) the interaction between $Zakat_{bt}$ and $Rate_t$, multiplies the $Zakat_{bt}$ variable with the discount rate as applied by the central bank on liquidity loans to private banks. Such policy rate is modified as follows: we subtract the minimum value, 7.5%, and divide by the standard deviation 2.43%. In this way, the coefficient on $Zakat_{bt}$ can be interpreted as the effect of a one standard deviation increase in silver price volatility for banks that are one standard deviation more exposed to Zakat, in the minimum rate (7.5%). The interaction can be interpreted as the additional effect on the previous effect of a one standard deviation increase in the discount rate. Columns (1) and (2) report the ATM share exposure to Zakat using the standardized share of branches in Sunni-majority cities. Columns (3) and (4) report the deposit ratio exposure to Zakat using the standardized ratio between the average deposit account for bank b divided by the wealth threshold, Nisab-i-Zakat, for the year. The bank-level controls reported here vary at the t level and are the Capital to Assets ratio, the ROA (return on assets), the government bonds to total assets ratio, the deposit share of liabilities, and the natural logarithm of total real assets. The number of Observations and Adjusted R^2 (Adj. R sq.) of each regression is reported in each panel. For the ATM share, we can use the full sample with 1,060,137; for the deposit ratio exposure, we observe this variable between only 2005 and 2009, which includes only 662,744 loans. The Mean and Standard Deviation (S.D.) of the dependent variables are reported in the last two rows of the table, respectively. ***, ** and * indicate significance at the 1%, 5% and 10% level, respectively.

Table 6: Zakat and Firm Investment - Firm Controls

Variables	(1) Fixed Assets	(2) Working Capital	(3) Total Investment	(4) Fixed Assets	(5) Working Capital	(6) Total Investment
$Zakat_{ft}$	0.010	-0.004	0.001	0.020	-0.082	-0.037
	(0.015)	(0.013)	(0.007)	(0.077)	(0.105)	(0.068)
$Zakat_{ft} \times Rate_t$	-0.020	0.015	-0.006	-0.085**	0.111*	0.012
	(0.040)	(0.049)	(0.023)	(0.040)	(0.063)	(0.039)
Effect in S.D.				19.1%	19.2%	
Exposure	ATM Share	ATM Share	ATM Share	Deposit Ratio	Deposit Ratio	Deposit Ratio
Observations	642	642	642	642	642	642
Adj. R sq.	0.211	0.076	0.211	0.214	0.076	0.166
FE f, fs, sy, b, bs, by	Yes	Yes	Yes	Yes	Yes	Yes
Mean Dep. Var.	0.002	-0.042	-0.013	0.002	-0.042	-0.013
S.D. Dep. Var.	0.245	0.285	0.189	0.245	0.285	0.189

Notes: This table reports OLS estimates of equation (2); the unit of observation is the firm f at time t (in this case year). Fixed effects are included for firm, year, number of banks, sector–year, number of banks–year and number of banks–sector, as reported in the third-last row FE. Standard errors are clustered at firm level; the number of clusters is 237. Fixed Assets measures the investment in fixed assets calculated as the growth of fixed capital assets minus depreciation, Working Capital measures the spending in working capital as the growth of working capital, and Total Investment measures the overall investment of the firm as the growth in its overall assets net of depreciation. These variables are regressed on the following: 1) $Zakat_{ft}$ is the standardized exposure of firm f to Zakat, obtained through the average exposure of each bank with which firm f interacted, weighted by the relative size of lending of firm f from this bank; 2) the interaction between $Zakat_{ft}$ and $Rate_t$, multiplies the $Zakat_{ft}$ variable with the discount rate as applied by the central bank on liquidity loans to private banks. Such policy rate is modified as follows: we subtract the minimum value, 7.5%, and divide by the standard deviation 2.43%. In this way, the coefficient on $Zakat_{ft}$ can be interpreted as the effect of a one standard deviation increase in silver price volatility for banks that are one standard deviation more exposed to Zakat, in the minimum rate. The interaction can be interpreted as the additional effect on the previous effect of a one standard deviation increase in the discount rate. The bank exposures to Zakat are reported in the row titled "Exposure". Columns (1), (2) and (3) report estimates using the ATM share; Columns (4), (5) and (6) report estimates using the deposit ratio. The firm-level controls reported here vary at the t level and are the natural logarithm of real profit as a measure of profitability, the real administrative cost as a measure of cost effectiveness, sales as a measure of size, firm equity as a measure of safety, and the liquidity ratio defined as the acid test. The number of Observations and Adjusted R^2 (Adj. R sq.) of each regression is reported in each panel. The Mean and Standard Deviation (S.D.) of the dependent variables are reported in the last two rows of the table, respectively. ***, ** and * indicate significance at the 1%, 5% and 10% level, respectively.

3.2.3 Investment Profile

In this section, we verify whether a change in the financial conditions of lending affects the investment profile of firms. Table 6 shows the results of equation (2), by constructing for every firm an indicator ($Zakat_{fy}$) that expresses how much a firm is exposed to Zakat, through the exposure of its bank. The left-hand variables are the growth in fixed capital assets, in working capital and total assets, all net of depreciation. The theoretical model predicts that in the presence of an increase in long-term lending, a firm would switch to short-term lending and correspondingly short-term investment.

The results in Table 6 are in line with this prediction. In both columns (1) to (3) and (4) to (6) of Table 6, in presence of Zakat and a high discount rate, there appears to be a redirection of investment from fixed capital assets to working capital, with no overall change in the level of investment. Because of the small effect of Zakat as caught by the ATM share exposure, the results of columns (1) to (3) are qualitatively in line with the predictions, but too small to be

precisely estimated. Conversely, because the deposit ratio exposure to Zakat generates larger effects on maturities and rates, we can verify that there is such a redirection of investment from fixed capital to working capital, in columns (4) to (6). The magnitudes are generally small, with a one standard deviation increase in silver price volatility and discount rate leading to a decline in capital assets growth of 0.08 points for firms with a one standard deviation higher bank exposure (19% of a standard deviation) and to an increase in working capital of 0.11 points (19% of a standard deviation). Appendix R reports two additional specifications of Table 6: 1) excluding all firm-level controls and 2) including both firm and bank-level controls. Finally in Appendix S we include the lagged Zakat variables to account for mean reversion and find no evidence of firms reverting to a higher fixed asset investment after a higher of low fixed asset investment.

3.3 Identifying Assumption and Robustness

Our identifying assumption relies on the interaction between silver price volatility and the discount rate affecting the loan choice between long- and short-term only through the reaction in their corresponding rates. However, there could be a variety of alternative hypotheses that may provide observationally equivalent results to those in Table 4 and Table 6. In this section, we explore the robustness of our identifying assumption to a few alternative hypotheses, by explaining the challenge, and point to the relevant appendix detailing each test.

Placebo – Eid Adha Celebrations It may be argued that silver price volatility has an impact on local banks regardless of deposit volatility: it could affect a specific asset tied to religious features to which Pakistani banks' exposure correlates with their depositors' exposure. Alternatively, silver price volatility may affect loan demand heterogeneously per bank because of bank specialization (Paravisini et al. (2015)) and we are only capturing an effect due to this channel. As a result, any exercise exploiting silver price volatility at any point in time would result in effects analogous to those found in Table 4 and Table 6.

To address this claim, we offer a placebo test to show that the interaction between silver price volatility and the discount rate affects loan characteristics only around Zakat time and that the risk of deposit withdrawal is the driver behind our results. For this purpose we replicate the same exercise for a different Islamic celebration: Eid al-Adha. This is a holy celebration, also based on the lunar calendar and taking place every year (see Table U1). It is dedicated to the First Testament event during which Abraham showed his willingness to submit to God and to kill his only son, Isaac, but was blocked at the last moment by the angel Gabriel (Jibra'il in the Islamic tradition, also meaning Holy Spirit). During this celebration there are important festivals and family gatherings; in particular there is a substantial deposit withdrawal toward

the purchases of gifts, particularly fresh bank notes to children and relatives,[19] and consumption of meat and other goods.[20]

The most relevant factors behind this placebo are: 1) there are large deposit withdrawals (1.2% as shown in Table T2) and 2) these withdrawals are not linked to the price of silver and there is no uncertainty over their size (there is neither a religiously-mandated threshold nor a levy). As a result, the Adha celebration is a fitting placebo for our purposes. In Appendix T we report further evidence on this and we produce a similar test to the one shown in Table 4, the difference being that, instead of calculating the volatility of silver price and analyzing loans given in the three months preceding the first day of Ramadan, we focus on the three months preceding Eid al-Adha and standardize the measure as previously described. Table T3 shows that we cannot reject the null hypothesis of no effect on lending characteristics.

Alternative Hypothesis on Selection into the Timing of Lending Table 4 and Table 6 could express a story of selection. Instead of charging all customers a higher rate for long-term loans, which generates a shortening of loan maturities, banks could simply delay loans to some customers, either in their number or volume, and lend during the period before Zakat to only a selected sample of borrowers. As a result, there would emerge a case of selection into the timing of loans during the months before Zakat. For example, "higher value" customers may be led to wait until the end of Zakat and "lower value" customers offered a loan: hence the change in loan characteristics would be simply due to a change in the applicant pool. In such a case, because some firms are "selected out" of the Zakat treatment, then we are simply observing how the average conditions of loans to some specific firms change in response to the discount rate.

If the previous argument applies, then we should observe an abnormal decline (or increase) in banks' overall operations during the quarter which immediately precedes Zakat. As a result, we collapse the data at bank–time (quarter–year) level and verify two key indicators: 1) the loan number share, defined as the number of loans given in that quarter over the total number given in the year, and 2) the loan volume share, defined as the total volume of loans in PKR divided by the overall volume of loans given in the year. Appendix U, Table U1, shows the results both in the case of the ATM share in Panel A and deposit ratio in Panel B, in which there does not emerge any movement in the overall activities of banks. Therefore, we can claim that, even if there may be selection in the timing of loans during the Zakat period, it does not appear either to be statistically detectable.

An alternative margin along which banks may adjust to Zakat, may emerge from another dimension of "selection into the timing of lending": the end-date of the loan. In order to limit the withdrawal of funds from the central bank at expensive rates, banks may time the

[19]There exists a common tradition of providing gifts to children through fresh bank notes on Eid al-Adha. For example, refer to http://www.dawn.com/news/1194767. In fact, during this period the State Bank of Pakistan issues an exceptional amount of currency to satisfy individual demand for notes; see http://www.dawn.com/news/983109/fresh-currency-notes-for-eid.

[20]See Gulf Base, 2015: "The State Bank of Pakistan (SBP) on Tuesday injected Rs61.90 billion into the money market through its open market operation (OMO) to help ease liquidity shortfall stemming from Eid-related cash withdrawals from the banking system" (available at http://www.gulfbase.com/news/pakistan-injects-rs61-9b-into-money-market/283154).

repayment of their loans to occur before the deposit withdrawal coinciding with Zakat. In Figure U1, we provide descriptive evidence consistent with such behaviour, with banks timing a substantially higher share of loans to expire between two and three months before Zakat. Interestingly, the same expiration takes place before the Eid Adha celebration, presented in the previous paragraph.

Alternative Explanation on the Quality of Lending A competing argument to our mechanism could state that, in periods of higher cost of funding, the pool of firms applying for a loan could change, as Jiménez et al. (2014) show. As a result, the effects found in Table 4 are simply due to the selection of worse/better borrowers. To verify whether this is the case, we obtain additional information on the loans given by banks over this period and collapse it at bank–time level. Specifically, to measure the "quality" of lending given by banks, we use all available information and focus on three indicators: 1) the share of loans that are secured and hence present a collateral against the value of the loan; 2) the share of loans in which customers have some sort of rating (by the bank or by third-party agencies/firms) and 3) the share of loans with customers presenting a rating previously given by the bank. In Appendix V we can observe that, regardless which identification we use, there is no movement along any direction. Hence the quality of lending, either as measured by the "safety" of customers, proxied by whether a loan is secured, or as measured by the "information" on customers, proxied by the presence of a rating, does not respond to deposit volatility for any level of the discount rate.

Alternative Effect through Bank Competition One possible warning against the main results may relate to the role of bank competition. Because banks are heterogeneously exposed to deposit volatility, interpreted as a change in their marginal cost of lending, then firms could move from more affected banks (which raise the long-term rate more) to less affected ones (which may increase this less or not at all). Although this is plausible, this phenomenon is a limited one for four main reasons: 1) Pakistani firms tend to be credit constrained, in line with other South Asian economies as reported by Banerjee and Duflo (2014) in India; 2) firms and banks tend to establish long-term relations, so that it may be cheaper to stay with the current bank and switch maturity rather than reallocate lending across banks (as shown theoretically in subsection "Bank Competition and Deposit Volatility" of Appendix B), 3) consistently with this, we do not observe a reallocation of loan amounts across banks (which goes against the previous argument) and 4) large firms also register this maturity-shortening effect, despite being the ones who could exploit this credit/maturity reallocation the most (as shown in Table 6).

However, in order to analyze more deeply this concern, Appendix W extends the result of Table 4 by removing firm-time fixed effects. This broadens the scope of the analysis by using variation also from firms having access to only one bank, hence a within-bank and within-firm analysis. These regressions show that even in this case, the main results still apply, with smaller magnitudes observed for the ATM share case. We also provide two empirical tests to discuss this possibility further in Appendix X:

1) we show that the *relative* composition of maturities does not change, by showing that the share of "maturity days" that firm f receives from bank b at time t does not correlate with the Zakat variables.

2) we replicate the results of Table 4, controlling for an Herfindahl Index of loan maturity composition at firm level, both as a control and interacted with the firm fixed effect, which does not alter our main findings.

4 Policy Implications and External Validity

In the next two subsections, we evaluate a policy response to the deposit volatility generated by Zakat and discuss the external validity of this work.

4.1 Quantifying the Effect of a Targeted Liquidity Program

In this section, we combine the results of the theoretical model to quantify the output gains of a targeted liquidity program aimed at neutralizing the uncertainty effect of Zakat, by providing banks with liquidity at temporarily lower rates. Our theoretical model predicts this rate to equal the deposit rates, which averaged 5% in Pakistan between 2002 and 2010 (see Appendix Q).

Exploiting the assumptions made in the theoretical section and carefully discussed in Appendix A, we can quantify the output effects of Zakat, by using only information from the credit registry. This presents an obvious data advantage because we can use information that summarizes more than one million loans over almost a decade and with a credible identification. In Appendix Y, we show that starting from the definition of output in the theoretical model, and through a few transformations, we can reach the following expressions

$$\left.\frac{\partial \overline{Y}}{\partial v}\right|_{r_{CB}} = -\sum_{m=1}^{5} s_m \left(r^*_{L1,m} - r^*_{L1,1}\right) \frac{\partial r^*_{L1,m}}{\partial v} \quad \text{and} \quad \left.\frac{\partial \overline{M}}{\partial v}\right|_{r_{CB}} = -\sum_{m=1}^{5} s_m \frac{\partial r^*_{L1,m}}{\partial v} < 0$$

which respectively quantify how the output in the economy, $\overline{Y}$, and the average maturity, $\overline{M}$, change in presence of deposit volatility, v, for a given discount rate r_{CB}. In this expressions, the subscript m reports the maturity class of a loan (1 year or less, 2, 3, 4 or 5 or more) as introduced earlier. The output expression states that this effect is the sum across all maturity classes of the product of three elements: 1) the share of loans with a given maturity m, s_m, which is observable; 2) the interest rate spread between the average loan with a maturity m and the 1 year loan, which is also observable; 3) the increase in the lending rate of a loan with maturity m with volatility, which was estimated in 3.2.2. Similarly the expression for maturities is the sum of the product between the loan share and the rate response.

Table 6 reports the main results of this section given the average silver price volatility and combining both the ATM share exposure and the deposit ratio one. Two key results emerge. First, the average gain of output generated by Zakat is 0.042% under the ATM share and 0.205% under the deposit ratio. Second, this program would lead to an average increase in

loan maturities: 4.71% under the ATM share exposure and 22.79% under the deposit ratio one. Interestingly, although these results are obtained using information from only the credit registry, they are in line with those of previous studies of the effect of maturity structure on productivity. For example, Schiantarelli and Srivastava (1997) and Schiantarelli and Sembenelli (1997) find through a production function estimation using panels of firms that longer-term finance is associated with productivity gains of a similar magnitude. Analogously Terry (2015) finds that quarterly reports lower firms output by 0.1%, within the interval of our estimates, by generating a reallocation away from R&D (long-term investment) to alternative short-term activities. Although these studies start from different conceptual frameworks, they also conclude that the reallocation from long- to short-term investment tends to play the most important role in such a productivity effect.

One important implication of our findings is that the maturity and the timing of firm investment matters; indeed, phenomena that may be considered "temporary", such as a period of high uncertainty on banks, may then be reflected on firms through higher long-term lending rates. This may consequently redirect investment toward the short term and, possibly, leave firms in a low-productivity horizon. With this respect, an intervention by the central bank to temporarily contain liquidity costs because of the uncertainty experienced by banks, can both stabilize the banking system and generate real effects by lowering the long-term lending rate. This is in line with the role played by the Y2K options, introduced by the New York Fed in anticipation of an expected aggregate liquidity shortage generated by the millennium date change (Sundaresan and Wang (2009)).

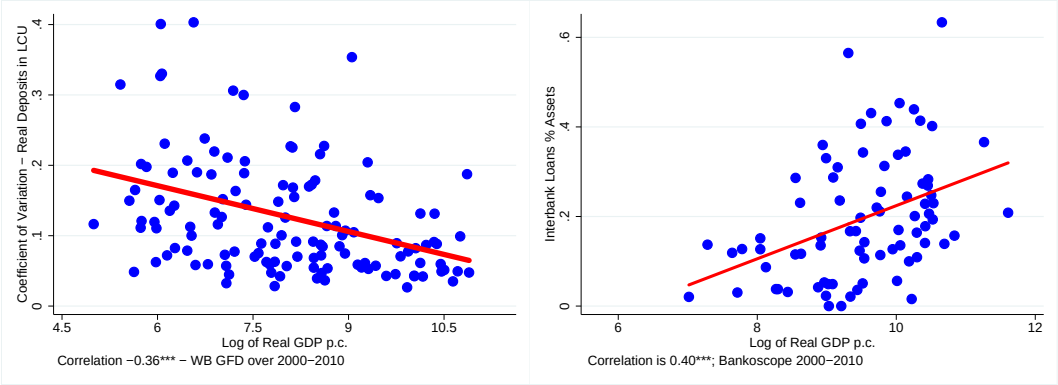
Note that our results pertain to a specific type of deposit volatility, generated by fluctuations in silver price, and counterfactual liquidity program to address this narrowly defined problem. At the same time, although our methodology allows to use exclusively information from the credit registry, this comes at the cost of accepting the specific assumptions of the model (i.e. functional forms of firms' productivity and shock, perfect competition in production and finance), which may limit the generality of the current exercise. Finally, we are not accounting for the possible side effects of this policy (e.g. inflation, moral hazard), which may depend on the execution of the liquidity program.

Table 6: Output Gains of a Targeted Liquidity Program

(1)	(2)	(3)
Variable	ATM Share	Deposit Ratio
Output Gains	0.042%	0.205%
Maturity Increase	4.71%	22.79%

Notes: This table presents a quantification of the output gains and maturity increases generated by a targeted liquidity program to address Zakat by providing banks with temporarily cheaper liquidity. These are calculated through the expressions reported in the text, given the average silver price volatility, the average discount rate and the average exposures through the ATM share and deposit ratio.

Figure 7: Deposit Volatility, Interbank Markets and GDP per Capita



Notes: The left panel shows a scatter plot between the log real GDP per capita (p.c.) on the x-axis and the variation coefficient of cyclical real bank deposits over the same period on the y-axis. Data on log of the GDP per capita are in 2005 constant dollar from the Penn World Tables (Feenstra et al. (2015)); bank deposit data are from the Global Financial Development database available in World Bank (2015). The correlation between these two variables is -0.36 and is statistically different from zero at 1%. All presented data on GDP and deposits are between 2000 and 2010. The right panel reports data on the share of interbank loans as a share of assets for 145 countries. Each dot is a country and this is derived from Bankoscope database, data are aggregated for a country and between 2000 and 2010. The log of real GDP per capita is taken from Penn World Tables. The correlation between these two variables is 0.40 and is statistically different at 1%.

4.2 External Validity and Policy Implications

Although the existence of our mechanism does not depend on the income level of a country, it is likely to be more relevant in low-income countries. For any given level of deposit volatility and liquidity cost this would be the case because LICs tend to exhibit financial systems mostly bank-based, with their banks being on average more deposit-funded. Appendix Z provides cross-country evidence on these points, which are likely to exacerbate the real effects of any bank-related financial distortion.

However, in addition to this, low-income countries also present both a higher volatility of bank deposits and interbank markets that are very small or often non-existent. Whereas the first result is consistent with the volatility and development literature,[21] the second element has seldom been discussed in preventing banks to smooth deposit shocks effectively. The combination of these two elements would give rise to a strong effect of our mechanism on shortening loan maturities, as originally shown in Figure 1. This is in line with the recent orientation of policy makers, who acknowledge the lack of long-term finance as a supply problem and banks as responsible for this. In this respect, the Global Financial Development report by the World Bank (2015) presents a survey of financial development among financial sector practitioners (bankers, central bankers, regulators, academics), and two important messages emerge from this survey: 1) access to long-term finance is a supply problem (75% of respondents agree) and 2) domestic banks play the most important role in access to long-term finance (61% agree).

Our analysis shows that one reason behind this supply problem in long-term finance may be the lack of a steady, predictable and accessible flow of liquidity to commercial banks. In fact, most banks in low-income countries beyond not having access to a local interbank market,

[21] As discussed in Koren and Tenreyro (2007), low-income countries present a higher volatility of income both because of a stronger exposure to more volatile sectors (e.g. agriculture) and informality. In a standard intertemporal model, such income volatility generates savings dispersion because of consumption smoothing, and within the formal banking system this leads to deposit volatility.

cannot use international capital markets either because of local regulation or international reputation. At the same time, most central banks in LICs are either unable or unwilling to provide liquidity on a predictable basis. In Appendix Z (Table Z1) we present data on the status of discount window facilities for all countries in Africa, as described by local or IMF/World Bank documentation, and find that more than 50% of central banks are not actively engaged in these operations. Linking this back to our theoretical model, in absence of alternative liquidity for commercial banks, then the implicit cost of liquidity tends to infinity, $r_{CB} \to \infty$. This makes long-term finance infinitely costly for banks and generates extensive redirection toward the short term.

5 Conclusions

In this paper, we proposed a mechanism through which the interaction between bank deposit volatility and liquidity cost can alter banks' funding costs. The higher the cost of accessing alternative liquidity to replace volatile deposits, the higher the tendency of banks to pass this cost onto long-term rates, which consequently promotes a shortening of loan maturities, leading to less long-term investment and output.

Our empirical analysis focuses on Pakistan because we can combine the universe of corporate loans between 2002 and 2010 to a unique natural experiment in deposit volatility. For this purpose, we exploit the payment of a Sharia levy on bank deposits, Zakat, which is linked to the international price of silver and generates exogenous variation in deposit volatility linked to silver price volatility. Combining this with bank-level cross-sectional exposure to Zakat withdrawals (ATM share and deposit ratio), we find that a higher silver price volatility and discount rate lead more-exposed banks to shorten loan maturities, reduce the lending rate and not change loan amounts. We also find an increase in agreed long-term lending rates, a decline in the share of long-term loans and an increase in very short-term loans, which is consistent with the financing redirection. At the same time, firms connected to more-exposed banks leave the total investment level constant, but change its composition by reducing fixed assets and increasing working capital.

In the last section of the paper, we quantify the output gains of a policy counterfactual in which the State Bank of Pakistan could provide targeted liquidity to banks, at special rates, during the Zakat period. In order to evaluate this program, we combine the theoretical and empirical results using information from only the credit registry. Our results point toward an output gain of 0.042%, under the ATM share exposure, and 0.205%, under the deposit ratio one. We discussed that such mechanism may be more extensive in African countries, which present a high deposit volatility with small or non-existent liquidity markets. Therefore, we propose that, among several institutional reasons for the lack of long-term finance and investment, the lack of functioning liquidity markets and central bank institutions may be key. Further research in the field of banking and development will allow to expand these results and provide further guidance toward optimal policy.

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Chapter 2 - Bank Deposits and Liquidity Regulation: Evidence from Ethiopia*

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Introduction

Deposits are a major source of bank funding. Beyond being a key element in financing the quantity of bank credit, they can also directly shape its quality through various channels: forcing liquidation (Diamond and Dybvig, 1983), monitoring risk (Calomiris and Kahn, 1991) and affecting the optimal capital structure of banks (Allen, Carletti and Marquez, 2015), among others. In this paper, we study how deposits respond to the regulation of bank liquidity, defined as the mandatory holding of safe assets (cash, government bonds, other liquid assets). Our banking model highlights how liquidity regulation can affect depositors' behaviour and we exploit a unique policy change in an emerging market to assess empirically this mechanism.

In particular, we restrict our attention to liquidity regulation in the absence of deposit insurance and banks' ability to commit on holding safe assets. We do this for two reasons. First, because there exists a consensus on the role of financial regulation when deposit insurance is in place (Beck, Carletti and Goldstein, 2016), while fewer contributions explore theoretically and empirically how banking changes when such regulation is introduced and deposit insurance is absent. Second, because this became particularly relevant after the 2009 global financial crisis and the 2010-2012 European debt crisis, which demonstrated that systemic shocks can affect both the stability of banks and the fiscal capacity of governments. In such cases, liquidity

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regulation can be particularly important given that: 1) deposit insurance may be perceived as not credible; 2) banks' safety and solvency may be questioned by depositors.

To pursue this question, our paper focuses on a specific regulatory episode in an emerging market (Ethiopia), which offers the ideal environment for three reasons: 1) it does not present deposit insurance; 2) it exhibits an unexpected policy change that increased the bank liquidity holding by 25% in one quarter of 2011; 3) its local banks are risky and enjoy a limited credibility by depositors on their liquidity (because of underdeveloped payment systems, historical cases of default, their relatively novel establishment). These factors make both banks not credible in their commitment to safety and local depositors very cautious in response (Bachas et al, 2017).

Our mechanism shows that if there is no deposit insurance and banks are unable to commit to safe assets, then limited liability pushes banks to choose risky projects over safe ones, as profits are appropriated in the good state and losses are passed on depositors in the bad state. In response, depositors anticipate this scenario and ex-ante lower their optimal deposit level. However, if the central bank imposes a liquidity requirement, through a minimum level of safe asset holding in every state of the world, this moderates both profits and losses. It consequently increases depositor repayment, stimulating deposits. In cases of severely risky financial systems, we show that liquidity regulation can even lead to higher bank profits, if deposit growth exceeds the decline in the intermediation margin and loan provision. As a result, branch installation (as a proxy for financial development) also rises, as higher profitability leads to more branch opening and provision of additional loans. In our model, liquidity regulation is valuable because of the timing assumption: banks are unable to convince depositors of their safe asset holding because of limited liability. Therefore, liquidity regulation is needed to create a commitment in holding safe assets. Our paper is conceptually related to the work of Calomiris, Heider and Herova (2015), who develop a theory of bank liquidity requirements, showing both the effect on deposits and credit allocation in a more complete theoretical model. At the same time, these results are also in line with the literature showing the liquidity benefit of holding public bonds (Holmstrom and Tirole (1998), Krishnamurthy and Vissing-Jorgensen (2012), Gennaioli, Martin, and Rossi (2014)).

We are the first to show empirically that liquidity regulation can promote the inflow of bank deposits, profits, branch-installation and that enhanced bank safety is the channel through which this takes place. Such policies have been implemented in several countries over the past century (Edey and Hviding, 1995). However, this issue has been difficult to study for a variety of reasons. To begin with, data availability on the banking industry, particularly in emerging markets, is a severe limit: except for a few, yet incomplete, sources (i.e., the Bankscope database), most banks are reluctant to publish any documentation that goes beyond the mere legal obligations. However, even when sources are available, they are – unsurprisingly – of low quality, generally incomplete, and only focused on a few key financial variables, with limited details on branching and geographical outreach. In addition to this, the power of the test is generally a sizable problem: most liquidity regulation policies are announced quarters/years before the implementation and only gradually brought into operations. This makes it hard to

track any behavioural change or, in any case, changes with enough statistical power to study depositors' reactions. Finally, as our model shows, liquidity regulation has a stronger effect on depositors in risky financial systems, with few countries presenting the simultaneous strong variation in the size of regulation combined with a risk-prone banking industry.

For this reason, we investigate a unique case study that addresses the previous concerns. In mid-March 2011, the National Bank of Ethiopia (NBE) approved a directive on liquidity requirements, obliging all private commercial banks to start purchasing 0.27 government bonds for every unit of private sector lending by April 2011. While it could be questioned whether this is a liquidity regulation, as these bonds may be far from liquid and risk-free; we believe this is not the case for two reasons. First, such bills can be exchanged with liquidity by the central bank (article 7 of the directive). Second, given the lack of an interbank market, these bills have de-facto recreated an interbank system by allowing banks to transfer liquidity claims.

The identification of the policy effects is achieved by combining the large and unexpected time-series change generated by the regulation with cross-sectional variation in bank sizes (big versus small banks). This emerges from the theoretical model that prescribes a heterogeneous effect of the treatment, given by a supermodularity between bank safety and size. To address the data limitations previously mentioned for the Ethiopian case study, we have constructed a variety of unique databases through which we can track the whole financial system. Through confidential contacts with the NBE, we had access to the regulation documents and could interview senior executives for all private sector banks, which provided substantial insights on how this regulation affected their business. Regarding the available datasets, we track three key indicators of bank behaviour:

1) bank balance sheets with monthly frequency, which allow to observe the key modelling variables (safe assets, deposits, loans);

2) a new map covering over 90% of bank branches opened in Ethiopia between 2000 and 2015, including their city and region, telephone numbers and other information;

3) a digitization of all annual reports in the five years around the policy change.

Our results indicate the existence of a deposit inflow as banks amass more liquid assets in response to the regulation. This also leads to more lending and an increase in branch-installation. While the effects on profitability enjoy a lower power because of yearly observations, in general we observe a slow down in profit growth (statistically different from zero at 10%), but not a negative effect.

This paper participates to the literature on the relation between deposits and financial regulation. From a theoretical standpoint, Diamond and Dybvig (1983) were the first to associate depositor behaviour to financial institutions and regulation. Calomiris and Kahn (1991) and Diamond and Rajan (2000) highlight the discipline role of deposits and how this can change when financial regulation is introduced. Allen, Carletti and Marquez (2015) discuss how financial regulation can affect deposit behaviour and consequently bank capital structure, while Allen, Carletti and Marquez (2011) look at asset-side monitoring and how that affects capital choice and depositor remuneration. The empirical literature on these topics is relatively limited

and our contribution is mostly directed to fill this gap. Barth, Caprio and Levine (2001, 2004) show that countries that with more restrictive regulatory regimes are more exposed to banking crisis, but do not present necessarily poorly functioning banks. While through a cross-country and cross-bank analysis, Laeven and Levine (2009) show that the effects of financial regulation, both on liabilities and assets, depend remarkably on governance indicators and find a large heterogeneity in this respect. Our paper also contributes to a literature on depositors response to exogenous changes. For example, Bustos, Garber and Ponticelli (2016) and Gilje, Loutskina and Strahan (2016) study how exogenous shocks, respectively to technology and wealth, affect the level of deposits and how this translates into credit. Another growing literature studies depositors' responses to changes in deposit insurance. Iyer et al (2016) study a run on Danish banks that limited deposit insurance coverage and find a differential reallocation of deposits across-banks. Iyer, Puri and Ryan (2016) investigate the relation between depositors' response and solvency risk in India, by dissecting the behaviour of different depositor classes to these events. Ippolito et al (2015) find the emergence of double-bank runs (both from borrowers and depositors) in the wake of the European interbank market freeze registered in 2007. Iyer and Puri (2012) show that uninsured depositors are the most sensitive to bank runs and that networks and depositor-bank relations can mitigate runs. Finally, Ioannidou and de Dreu (2006) were among the first to study the impact of explicit deposit insurance on market discipline in a natural experiment in Bolivia.

In Section 1, we present the theoretical framework, describing first the economic environment and then investigating the bank decision problem. In Section 2, we discuss empirical evidence from the policy change in Ethiopia and a variety of robustness checks. In Section 3, we present some concluding remarks.

1 Theory

1.1 Economic Environment

The economy comprises a continuum of locations on the unit line, and each point is populated by a household engaging in a saving decision. The bank decides how many branches to open, $\beta \in [0,1]$, which is costly but allows it to reach a new locus and to interact with agents. If $\beta = 1$, then all locations are reached, while with $\beta = 0$, no branches are opened. Once a branch is installed, the bank interacts with a depositor, who chooses how much to deposit, $d \geq 0$, given a remuneration $R_D \geq 1$. These liabilities are collected and allocated in two assets: a share in risky loans, $l \in [0,1]$, and the remainder in a liquid asset, $s = 1 - l$. There exist two states $\sigma \in \{G, B\}$: in the good state, $\sigma = G$, which occurs with probability $p \in (\underline{p}, 1)$, the bank earns on risky loans a gross rate $R_G > 1$, while in the bad state, $\sigma = B$, which occurs with probability $1 - p$, the bank earns $R_B \in [0, 1)$. In contrast, the return on the liquid asset is positive, deterministic, higher than the deposit rate, and lower than the expected loan return, $R_S \in [R_D, pR_G + (1-p)R_B]$. Prices are given and therefore if G occurs, the bank earns R_S on liquid assets, R_G on the remainder, and pays R_D to depositors. Given the assumptions on the

rates, the good state is always profitable and the bank always repays. However, if B occurs, given the liquid asset choice s and limited liability, the bank pays

$$R_{DB} = \min\{R_D, sR_S + (1-s)R_B\}$$

the minimum between the deposit rate $R_D \geq 1$ and the return on the liquidated assets, composed by the sum of the gross return on liquid assets, sR_S, and the return on the risky assets, $(1-s)R_B$.

This economy presents the following four stages:

1. the bank invests in financial development, deciding on the number of branches, β;
2. households reached by a branch decide how much to deposit, d;
3. the bank decides on the amount of liquid assets, s;
4. the state σ is realized, the bank receives loan reimbursement, repays deposits, and collects profits, and the household consumes the repaid deposits.

The timing of the game clarifies a key intuition for the role of liquidity regulation: given the structure of returns, the bank is not keen to hold any safe assets. Limited liability allows it to keep the profits in the good state G, and to liquidate depositors with all that is collected in the bad state B. Depositors anticipate this and, given the constant rates, limit their deposits in the banking system. If the bank could commit to hold an amount of safe assets always securing R_D, then deposits would be higher, and profits as well. However, in a single shot game, such commitment is not credible and we delegate to liquidity regulation to solve this problem by imposing the amount of liquid and safe assets. Throughout this model, we shall switch off the possibility that prices change in response to agents' decisions: this can be interpreted as a price-taking assumption or introduced in order to be in line with the case studies we present in Section 2, in which prices are not the mechanism through which the policy affects the economy.

The game can be solved by backward induction. In terms of notation, capital letters refer to aggregate quantities at bank level, while lower-case letters refer to branch-specific quantities: l is the loan given in each branch and $L = \beta l$ is the aggregate number of loans given by the bank (analogously $S = \beta s$ and $D = \beta d$).

1.2 Bank and Liquid Assets

The profits of the bank are composed by an intermediation margin, $\pi(s)$, which emerges as the difference between payments on liabilities and income on assets, times the extensive margin given by the number of branches, β, and the intensive component being the amount of collected deposits in each branch, d.

At the last stage of the game, given that the extensive and intensive margins β and d are fixed, the bank can only affect profits by changing the intermediation margin and choosing the share of liquid assets to hold. The intermediation margin can be described by

$$\pi(s) = p[sR_S + (1-s)R_G - R_D] + (1-p)[sR_S + (1-s)R_B - R_{DB}].$$

In the good state, which happens with probability p, the bank earns returns R_S on the share of liquid assets s, R_G on the remainder $1-s$, and pays the deposit rate R_D; in the bad state, it earns R_B and pays a deposit rate R_{DB}. In the good state, bank profits are always positive and therefore the market deposit rate, R_D, is always repaid. However, in the bad state, this is not necessarily the case and the bank may default. Because of limited liability, the corresponding deposit rate can be described through the previously introduced $R_{DB} = \min\{R_D, sR_S + (1-s)R_B\}$. Therefore, if the bank collects enough profits in the bad state, it repays depositors with the market rate R_D and keeps the positive profits $sR_S + (1-s)R_B - R_D > 0$; however, in the opposite case, the bank passes its losses on to depositors and repays them with all the recovered assets, $R_{DB} = sR_S + (1-s)R_B$. Define $\widetilde{s}$ as the liquid asset level such that the bank is indifferent between repaying the market deposit rate, R_D, and liquidating its assets, $\widetilde{s} = (R_D - R_B)/(R_S - R_B)$, as $R_S > R_D > R_B$, which bounds $\widetilde{s} \in (0,1)$. As a consequence, the following holds true:

$$R_{DB} = \begin{cases} R_D & \text{if } s \geq \widetilde{s}; \\ sR_S + (1-s)R_B & \text{if } s < \widetilde{s}. \end{cases}$$

The deposit rate in the bad state, R_{DB}, equals the market deposit rate, R_D, if the liquid asset share exceeds the strictly positive threshold, $s \geq \widetilde{s}$; otherwise, it is given by the liquidated assets.

Liquidity Regulation In the absence of regulation, the bank simply maximizes the intermediation margin with respect to the share of liquid assets s, in the absence of any constraint

$$\max_s \pi(s) = p[sR_S + (1-s)R_H - R_D] + (1-p)[sR_S + (1-s)R_B - R_{DB}],$$

which leads to a trivial solution of $s = 0$, given that $p \in (\underline{p}, 1)$ with $\underline{p} = (R_S - R_B)/(R_G - R_B)$, and passes all losses on to depositors in the bad state, $R_{DB} = R_B$. The timing of the game makes this intuition trivial, because in the last stage, depositors cannot punish the bank for this decision. The regulation we study forces the bank to hold a level of safe assets $\rho > 0$, which adds to the previous problem the binding constraint $s^R = \rho$. Because the unregulated liquid assets equal zero, the regulation necessarily raises the deposit rate in the bad state (from $R_{DB} = R_B$ to $R_{DB} = \rho R_S + (1-\rho)R_B \; if \; \rho < \widetilde{s}$ or $R_{DB} = R_D \; if \; \rho \geq \widetilde{s}$).

In the absence of a repeated game setting or other externalities, the bank has no private incentives to keep any liquid asset. Therefore, the post-regulation margin is defined as $\pi(\rho)$, decreasing in the liquidity regulation parameter ρ.

1.3 Depositor Problem

In each branched location, given β, a representative household faces a two-period problem, by deciding on consumption in period 1 (i.e., the present) and in period 2 (i.e., the future), given a vector of prices $\{R_D, R_B, R_S\}$, states $\sigma \in \{G, B\}$ with probabilities p and $1-p$ and the choice

of the bank's liquid assets s. The household is endowed with income y only in the first period and faces financial market imperfections, which do not allow state-contingent transfers. Hence, consumption in period 2 is dependent on the state, which may be good G, with savings being remunerated R_D, or bad B, with remuneration $R_{DB}(\rho)$. The solution is a vector $\{c_1, c_{2G}, c_{2B}\}$, where each subscript number refers to the period, and G and B refer to the states of the future; such a consumption vector fully describes the deposit behavior d. We are implicitly assuming that when branched, a household always uses the banking system to deposit its savings, and several arguments in this respect have been raised in the literature. In the following problem, we adopt an additive and separable CRRA utility function:

$$\begin{aligned} \max_{c_1, c_{2G}, c_{2B}} \quad & c_1^{\alpha} + \delta[p c_{2G}^{\alpha} + (1-p) c_{2B}^{\alpha}] \\ \text{s.t.} \quad & c_1 + \frac{c_{2G}}{R_D} = y \\ & c_1 + \frac{c_{2B}}{R_{DB}(\rho)} = y. \end{aligned}$$

Here, $\delta \in (0,1)$ indicates the discount rate, $\alpha \in (0,1)$ indicates the relative risk aversion parameter, and p is the probability of the good state, while the state-dependent budget constraints are standard except that in the good state the discount rate is R_D and in the bad state it is $R_{DB}(\rho)$. The following saving/deposit function in locations reached by branches β emerges,

$$d(\rho) = y - c_1 = \frac{\delta^{1/(1-\alpha)}[p R_D^{\alpha} + (1-p) R_{DB}(\rho)^{\alpha}]^{1/(1-\alpha)}}{1 + \delta^{1/(1-\alpha)}[p R_D^{\alpha} + (1-p) R_{DB}(\rho)^{\alpha}]^{1/(1-\alpha)}} y,$$

which is always positive and increasing in $R_{DB}(\rho)$, and hence in ρ. The full solution to the problem can be found in Appendix A.

1.4 Financial Development and Regulation

In the first period, the bank decides how many branches to install, given the intermediation margin in each location $\pi(\rho)$ (which depends negatively on the liquidity regulation parameter ρ), the deposit level $d(\rho)$ (which depends positively on ρ), and some convex cost of branch opening $c(\beta)$. Its convexity can be justified by the fact that branch coordination costs can be larger the further a branch is from the headquarters (the locus in zero).

This financial development problem can be written as

$$\max_{\beta \geq 0} \Pi = \pi(\rho) d(\rho) \beta - \eta \frac{\beta^2}{2},$$

note that in this setting we introduce a new parameter η: this is a branch-opening technology parameter affecting both the average and marginal cost of branch opening. As clear from the solution of the branch-maximization exercises, this technological parameter maps into the overall size of a bank, in terms of installed branches. In fact, given that the marginal branch profitability is $\pi(\rho)d(\rho)$, then this leads to the solution $\beta = [\pi(\rho)d(\rho)]/\eta$, with the overall

profits being $\Pi = [\pi(\rho)d(\rho)]^2/2\eta$, loan volume $L = [\pi(\rho)/\eta]d(\rho)(1-\rho)$, liquid asset holdings $S = [\pi(\rho)/\eta]d(\rho)\rho$ and deposits $D = [\pi(\rho)/\eta]d(\rho)$. As a result, it can be noted that a bank with a higher η parameter installs less branches, hence collects less deposits and gives less loans. From this point onward we refer to η as a technology-induced parameter of bank size.

Liquidity Regulation as Safe Asset Purchase What happens to loan volume and branch installation when a positive shock to ρ occurs? Can such liquidity regulation policy promote loan volumes and branch expansion? The liquidity regulation parameter, ρ, imposes a mandatory share of liquid and safe assets s, given that $s^R = \rho$. It is clear that loan volume can increase in the financial regulation parameter, if and only if

$$\frac{\partial L}{\partial \rho} > 0 \rightarrow \epsilon_{d\rho} > \epsilon_{\pi\rho} + \epsilon_{l\rho}$$

the elasticity of deposit mobilization exceeds the sum of the elasticity of the intermediation margin and loan share with respect to the regulation parameter ρ. As shown in Appendix B, the previous expression simplifies to the following

$$\frac{\alpha}{1-\alpha} yA(\rho) > \frac{\rho}{1-\rho} + \frac{1}{1-\rho[(R_G - R_S)/(R_G - R_D)]}$$

with the expression on the left-hand side embedding the deposit component, with $A(\rho)$ decreasing in ρ because of concavity; in contrast, the right-hand side reports the profit component and is increasing in ρ. For given parameter values, it is possible to show that loan volume responds to the regulation parameter with the following effect,

$$\frac{\partial L}{\partial \rho} = \begin{cases} \geq 0 & \rho \leq \widetilde{\rho}, \\ < 0 & \rho > \widetilde{\rho}; \end{cases}$$

it increases if liquidity regulation does not exceed a threshold $\widetilde{\rho} = \widetilde{\rho}(p)$ and decreases if it does. Such threshold is increasing in the probability of bad state, $1-p$. This result is intuitive: the deposit response to the regulation is higher, the safer the financial system becomes because of the regulation. Hence, it follows that a risky financial system (with a high $1-p$) experiences a stronger deposit response to liquidity regulation. This result is key to our empirical analysis and is the driver of the effects highlighted in Section 2. Note that given the definition of L and β, conditions for an increase in loans are sufficient for an increase in branches.[1]

The upper panel of Figure 2 shows the right- and left-hand side expressions, with the shaded area indicating the region in which higher liquidity regulation promotes lending. In the lower panel, we show that such a region increases in the probability of a bad state. In the main scenario, we set $1-p$ to be 10% (solid line), which implies a threshold of $\widetilde{\rho} \simeq 0.33$. In the

[1]It is also important to highlight that in the case that the financial system already presents a level of safe assets higher than or equal to $\widetilde{s}$, which guarantees depositor repayment in any state, then imposing $\rho > \widetilde{s}$ leads to the opposite effect, as deposits do not increase given that there is no repayment increase, but the intermediation margin declines and this leads to lower profits, loans, and number of branches.

scenario in which this probability is brought to 15%, such a threshold correspondingly increases to $\widetilde{\rho} \simeq 0.5$, while if such a probability is reduced to 5%, the threshold follows to $\widetilde{\rho} \simeq 0.18$. In Appendix C, we report additional comparative statics with respect to both the probability of a bad state and other model parameters; however, this essential comparative statics on p shows how important the riskiness of the financial sector is for detecting a statistically significant effect.

These results can be summed up in the following proposition.

Proposition 1 *There exists a threshold in the mandatory share of liquid assets, $\widetilde{\rho}(p)$, such that in the presence of unbranched locations, $\beta < 1$, $\forall \rho \leq \widetilde{\rho}(p)$ the total loan volume $L = \beta d(1-s)$, the number of branches β, deposits per branch d, total deposits $D = \beta d$, and liquid assets S increase in the liquidity regulation parameter ρ. Such a threshold is increasing in the probability of a bad state, and hence decreasing in p.*

1.5 From Theory to Empirics

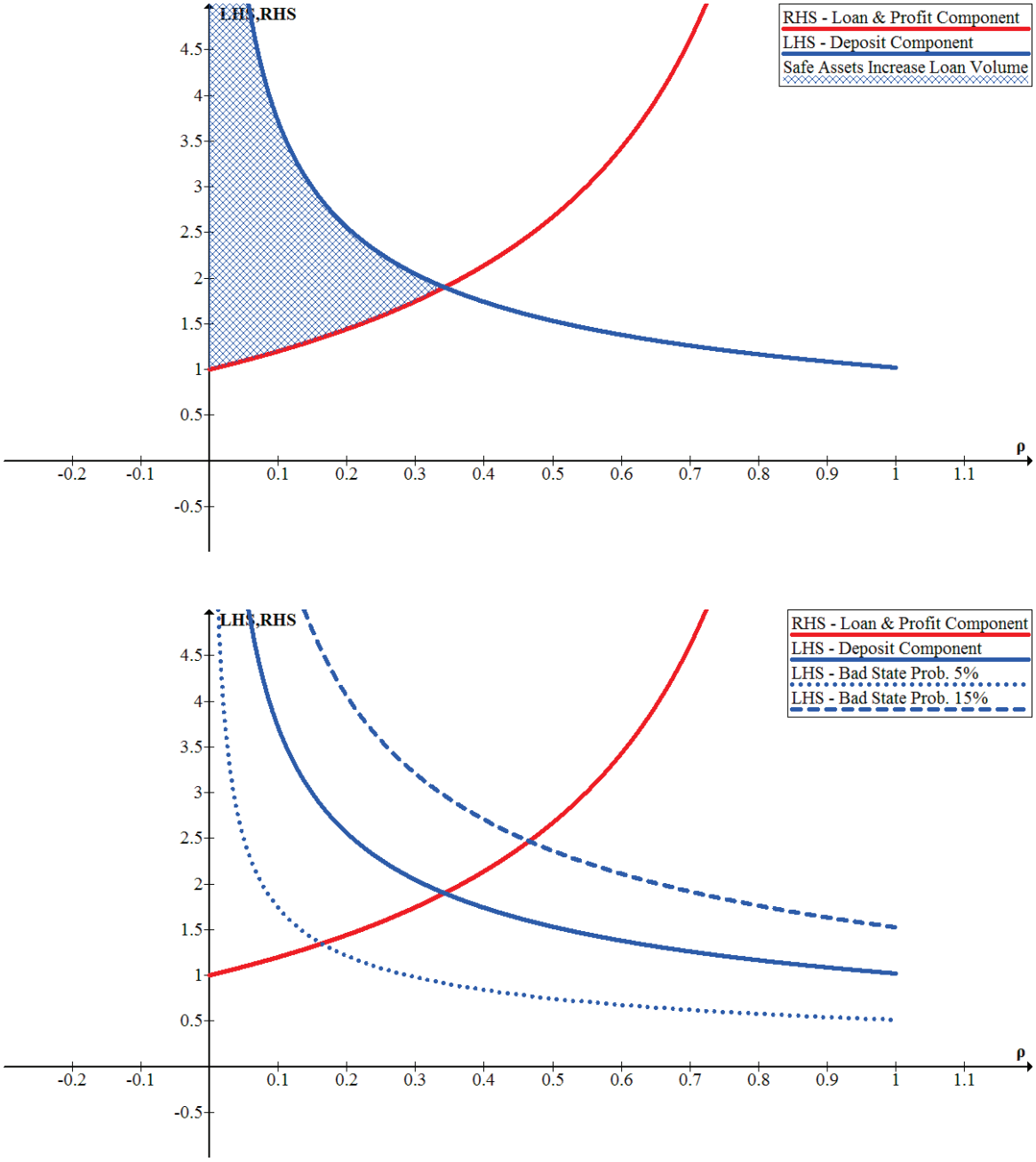
In the absence of an experimental setting for the application of this policy, we rely on a key modeling feature to identify the effect of financial regulation. Recalling the first-order condition $\beta = (\Pi/\eta)d$, both the equilibrium number of branches β and the response to the liquidity regulation policy $\partial\beta/\partial\rho > 0$ depend on the technology-induced parameter of bank size (i.e., η). This is a sufficient statistic for bank size, because it characterizes both a level effect (i.e., the number of branches before the policy) and an impact effect (i.e., the response to the policy), and we carefully combine this cross-sectional analysis to the time-series analysis. Proposition 2 updates Proposition 1 and guides it to the data.

Proposition 2 *The parameter of bank size η, measuring the technological endowment of the bank in terms of branch cost, affects negatively the optimal number of branches and the branch-installation response of the bank to liquidity regulation. If a set of banks is endowed with η_H and another set with η_L, with $\eta_H > \eta_L$, then the banks exhibiting η_L: 1) install more branches than the bank with η_H, $\beta(\eta_L)^* > \beta(\eta_H)^*$); 2) respond to the liquidity regulation policy by opening more branches than the bank with η_H, $\partial\beta(\eta_L)^*/\partial\rho > \partial\beta(\eta_H)^*/\partial\rho$).*

Therefore, all the predictions of Proposition 1 are differentially stronger for more efficient banks. This result is intuitive and is clarified in Figure 3. The more efficient bank makes more profits in every branch, because it has lower branch installation costs, and therefore it opens more branches because more are profitable (level effect), $\beta(\eta_L) > \beta(\eta_H)$. This prediction stays true also after the policy shock: both banks want to open more branches, but the more efficient bank opens more because it makes more profits in each single branch,

$$\frac{\partial\beta^*(\eta_L)}{\partial\rho} > \frac{\partial\beta^*(\eta_H)}{\partial\rho}.$$

Figure 1: Loan Volume Increases in Liquid Assets



Note: This figure plots the conditions under which loan volume increases in the regulated share of liquid assets. The x-axis reports the values of the liquid asset share parameter ρ, and the y-axis reports the values of the right- and left-hand side variables. As is clear from the inequality, the left-hand side is decreasing in the parameter (reported in blue), while the right-hand side is increasing (in red). This figure assumes that the bank rates are in line with the model and calibrated with the Ethiopian economy, as from NBE (2011), and that the other parameters are in line with the literature: $R_G = 5/4$; $R_S = 21/20$; $R_B = 0$; $R_D = 1$; $\delta = 0.9$, $\alpha = 1/2$; $p = 0.9$; $y = 20$. The shaded area reports the regions in which the regulation determines an increase in loan volume. The upper panel reports the main picture with $p = 0.9$. The lower panel reports three cases: $p = 0.9$ (solid line), $p = 0.85$ (dashed line), and $p = 0.95$ (dotted line).

The results of Proposition 2 can be described through the encompassing empirical model

$$v_{it} = \iota_i + \iota_t + b \cdot \eta_i \cdot \rho_t + \epsilon_{it}$$

in which the variable of interest v_{it} for bank i at time t (ie., branches, deposits, loans...) is regressed over a bank and time fixed effects, ι_i and ι_t, and an interaction between the technological bank-specific parameter, η_i, and the liquidity regulation parameter, ρ_t. Proposition 2 predicts that such interaction is negative, because banks with a higher branch cost parameter grow less after the policy.

Such model can be further generalized to test for the presence of parallel trends before the policy, leading to

$$v_{it} = \iota_i + \iota_t + \sum_t c_t \cdot \eta_i \cdot \iota_t + u_{it}, \tag{1}$$

in which the variable of interest v_{it} for bank i at time t is regressed over bank and time fixed effects, ι_i and ι_t, and an interaction of time fixed effects with the bank-specific technological endowment for every period t, $\eta_i \cdot \iota_t$. Equation (1) is the empirical model that we extensively use in this paper. A particularly attractive feature is given by the interaction, c_t, which allows us to test whether banks with different technological endowments are on parallel trends before the policy, by verifying that c_t are not statistically different from zero $\forall t < \widetilde{t}$, with $\widetilde{t}$ representing the time period in which the liquidity regulation change takes place.

2 Empirics

2.1 Evidence from Ethiopia

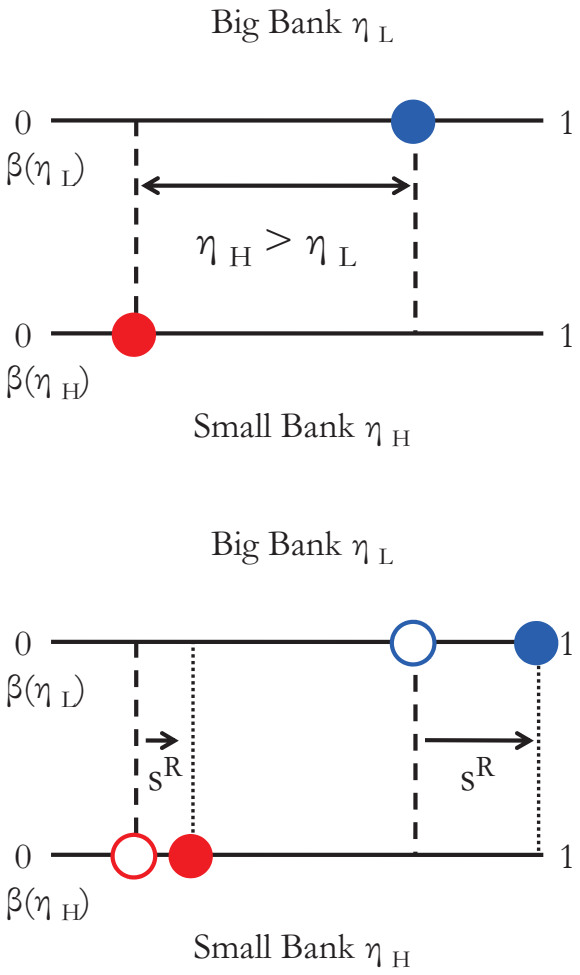
In this section, we present empirical evidence on Ethiopia and the behavior of local private banks, exploiting the introduction of a new liquidity regulation measure announced in mid-March 2011 and introduced at the beginning of April. On this date, the NBE issued a directive requiring all commercial banks to hold 27% of new loan disbursements in NBE bills.

The relevant aspect of studying the so-called "27% rule" is given by the unique nature of this shock: 1) it was unexpected and announced less than a month before implementation; 2) it caused a large accumulation of safe-assets by banks in one quarter. The asset share of safe-assets held by local banks passed from 25% to 30%, as shown in the next subsection, which corresponds to a 25% increase.

From a theoretical standpoint, this policy can be mapped as a positive shock to the s^R, which combined with the above conditions 1) and 2) make it ideal for our analysis.[2] It is

[2]The theoretical model predicts a stronger effect of regulation in the presence of a low initial level of regulation (low ρ) and high riskiness of the financial system (high $1-p$). We believe that given the level of financial risk in this economy, the Ethiopian banking system meets the criterion, given the absence of any deposit insurance scheme and the simultaneous presence of a remarkable asset and liability volatility. The variation coefficients of deposits and private sector loans, which can be interpreted as an index of dispersion of such variables, stands at 14% and 18%, respectively. This indicates that roughly 15% of a bank balance sheet is withdrawn and deposited back in a year. This is extraordinarily high compared to the 2–5% recorded in the Euro Area (Deutsche Bank

Figure 2: Heterogeneity and Identification



Note: This figure graphically depicts the identification in this empirical exercise. In the upper panel, we present the two banks assumed to be lying on two separate unit lines. One is bigger in equilibrium because it enjoys a low branch cost parameter η_L (i.e., Big Bank); the other is smaller because it enjoys a high parameter η_H (i.e., Small Bank). Here, there is a level effect in their respective branch number β, caused by the cost parameter. In the lower panel, our identification becomes clear: the time-series shock s occurs at the same time for all banks, but because of the cost parameter η it affects the Big Bank differentially more.

also important to highlight that the NBE Bills are not a profitable asset, as they pay a fixed remuneration of 3% per year, lower than the minimum deposit rate, 5%, or the average lending interest, 12% (National Bank of Ethiopia 2012)[3].

2012) or the USA (PricewaterhouseCoopers 2011). This concern was expressed also by the banks themselves. Indeed, during our interviews with local bank executives, we found that this is a core problem of local banks and we found supporting evidence for our "maturity mismatch" risk assumption going through the theoretical model.

[3]Therefore this policy as well as mandating liquid assets, also lowers the return on private sector lending, as banks are forced to purchase government bonds with a negative remuneration for every loan. As a consequence, this piece of financial regulation also includes a lending tax, which would generate an effect against the one we highlight here. The lending tax would lower lending, while the "liquidity effect" should boost lending by attracting new deposits. In this context, the liquidity effect is stronger than the tax effect, which is very small. In fact, before the policy a unit loan would deliver an average net 7% return (12% average lending rate minus 5% deposit rate), while after the policy it would deliver the same gross return, minus the net remuneration of this bills -2% times the amount of the purchased bills 0.27, hence $7\% - 0.27 \times 2\%$, this result in a 0.54% decline on lending returns. The small tax element was also confirmed during our extensive consultations with Ethiopian central bank executives and private bankers.

In order to test the implications of Propositions 1 and 2, we collect confidential data on the monthly balance sheet of all Ethiopian private banks between 2010 and 2013, on publicly available Annual Reports data on profits between 2008 and 2013, and we build a unique city-level map of Ethiopian branches, where for every bank we know in which cities all new branches have been opened, with respective month and year between 2000 and 2015.

Propositions 1 and 2 provide two fundamental elements to test the model: a shock to s^R promotes deposit growth; and cross-sectional variation in η characterizes a differential impact to the shock. Ethiopia is an exceptional context in which to test this model because as well as a large time-series variation in s^R, we find a large cross-sectional variation in some characteristics associated with η. Figure 4 presents the total assets of the 14 Ethiopian banks on March 2011, before the policy implementation, and there emerges a natural distinction between big and small banks. Indeed, there is a large discontinuity between the sixth bank, Bank of Abyssinia (BOA), with assets close to eight billion birr, and the seventh bank, Construction and Business Bank of Ethiopia (CBB), with assets below four billion birr.

Therefore, we set the hypothesis that large banks are also endowed with a better technology (lower unit cost) than smaller banks: thus, larger banks match the η_L case and smaller banks match the η_H case. For this reason, given that the largest six banks are more than twice as large as the remaining eight, we classify these banks as "more efficient" (hence presenting a lower cost of branch opening, η_L) and we define a dummy variable "Big Bank" taking unit value for all of these. The remaining are categorized as "less efficient" (embedding the parameter η_H).[4]

Once both the time-series and cross-sectional variation is clear, we present the following tests of our proposition.

A. Main Results. In this section we verify the predictions of Proposition 1 and 2 on the following databases.

1. Balance sheet data. Using monthly data, we verify that liquid asset purchases increase after the policy, that new deposits are collected in old branches, and loan volume also increases (Section 2.2.1).

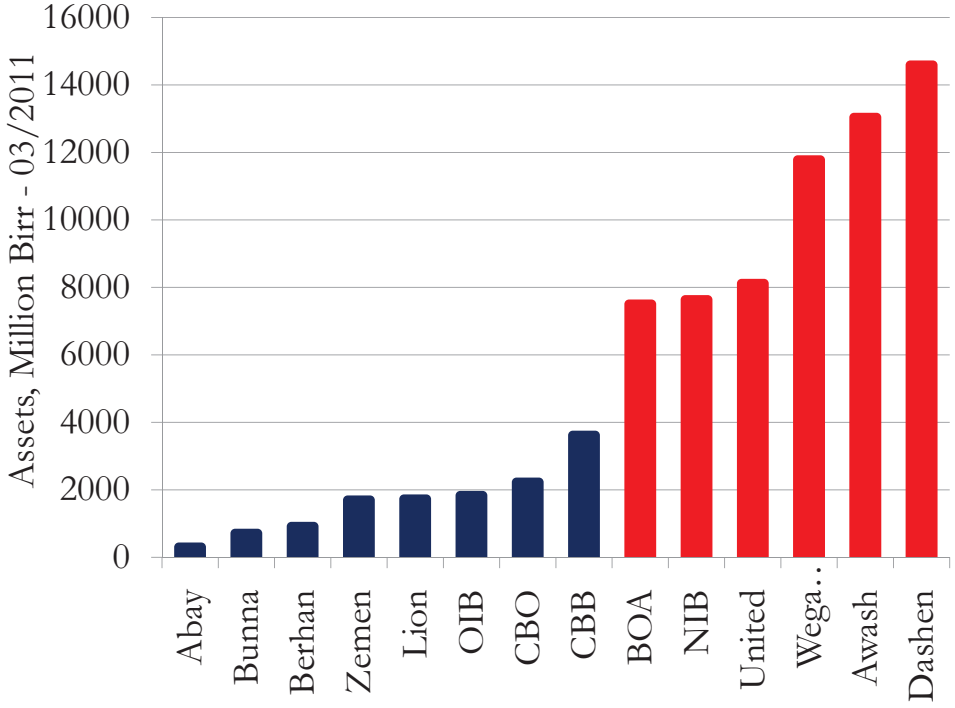
2. Branch map. Using monthly data, we give evidence that branch installation increases more markedly after the policy and more cities see their first branch installed after the policy (Section 2.2.2).

3. Annual reports. Using yearly data, we show that bank profitability does not decline in absolute value and actually increases for larger banks. We also show that the number of employees grows much more after the policy, as banks start to expand further (Section 2.2.3).

[4]In Appendix D, we provide a direct test of our hypothesis and show that "big banks" are not just larger, but also present 40% lower administrative costs over assets and 45% lower administrative costs over personnel. This result, though not a comprehensive test of a variation due to η, provides some evidence to support our identification.

B. Robustness Checks. In Section 2.3 we explore a variety of factors which might confound our estimates and verify the soundness of our results.

Figure 3: Bank Assets



Note: This figure reports a bar chart reporting the total assets of all Ethiopian private banks in March 2011, one month before the introduction of the policy. There is an evident existence of a substantial discontinuity between the third largest bank, Wegagen Bank (denoted by Wega..), and the sixth largest Ethiopian bank (BOA), and also between the sixth and seventh largest banks, BOA and CBB. The six largest banks are shown in red and are those that we classify as big banks in Sections 2.1.2 and 2.1.4. In Section 2.1.3, because of limited data on the long-run branch installation, we focus within the big banks and compare Awash and Dashen as big banks with BOA, CBB, NIB, and United.

2.2 Main Results

2.2.1 Balance Sheet Evidence

The policy change creates a large exogenous variation in the aggregate s^R, and from the point of view of the theoretical model, this leads to more liquid assets, which stimulate deposits and consequently lending. Because private banks are equally affected by the policy, but respond differentially based on their parameter η, we can produce a variety of tests to study Propositions 1 and 2 empirically. The following two are performed and presented.

1. Within-Year Compliance. We verify that NBE bills were indeed purchased as the policy prescribes and that the policy was not applied differently between big and small banks. Appendix E reports the test and results.

2. Quarter Variation. We report the quarter evolution of the main aggregates, removing bank-specific effects and seasonal fluctuations, showing the presence of a discontinuity at the policy change introduction, differentially stronger for larger banks.

All of these tests provide empirical support for the balance sheet predictions, and offer quantitative evidence in favor of our model.

Quarterly Variation

In presenting this test, we explore all available time-series information, rather than simply presenting a pre–post estimation, as clarified in equation (1). For this reason, we verify how the average deposits, lending, NBE bills, and liquid assets move during all the available quarters, and whether a differential trend is registered for big banks. To tighten the empirical exercise with the theoretical model, we regress the logarithm of real deposits and loans, while we reports the the NBE bills and safe assets as shares of the total assets of the bank. In fact, the variable s^R in the model is the share of assets held in safe assets, hence the policy change affects this variable, rather than just the log flow of safe assets.

The theoretical model predicts a discontinuity around the introduction of the policy, stronger for large banks, and a long-term effect following the discontinuity. For this reason we estimate the following model

$$v_{iqy} = a + \sum_{qy=1}^{13} b_{qy} \cdot d_{qy} + \sum_{qy=1}^{13} c_{qy} \cdot d_{qy} \cdot Big\ Bank_i + \iota_i + \iota_{iq} + \epsilon_{iqy}, \tag{2}$$

where the variable v_{iqy} is regressed on a dummy variable d_{qy}, which takes unit value for each quarter qy of the 13 available, an interaction of this dummy with the Big Bank dummy variable, a bank fixed effect ι_i, and a bank-quarter fixed effect ι_{iq} to account for seasonality. The coefficients c_{qy} are the core of this estimation and report the average differential evolution of the variable v_{iqy} for big banks. Note that while in equation (1) the sign of the interaction term was negative, because the theoretical model measured η, here the interactions are expected to be positive, because the big bank dummy measures the inverse of η. Such difference stays across all empirical exercises.

In Table 1, we present the coefficients c_{qy} across the available quarters, it is clear to see that until the introduction of the policy change, in Quarter 5, the coefficients on deposits, loans, NBE bills, and liquid assets are not statistically different from zero for big banks, leading us not rejecting the parallel trend hypothesis. However, Quarter 5 establishes the change in three important factors. First, NBE bills start getting purchased by all banks, who pass from holding zero of these assets to roughly 15% of their assets in these bonds, as shown in the upper panel of Figure 5. Secondly, overall liquid assets increase as well, both for big and small firms, by roughly 5%, as the bottom panel of Figure 5 highlights. These two information combined reveal that banks increased their overall liquid asset and switched composition from some type of safe assets toward the new NBE bills. Third, deposits react almost simultaneously and begin a

Table 1: Regulation and Banks: Quarter Variation

Variables	(1) Deposits Ln Mill. Birr	(2) Lending Ln Mill. Birr	(3) NBE bills Asset Share	(4) Liquid assets Asset Share
		Small Banks		
Quarter 2	0.0333	-0.0266	-0.00803	-0.0230
	(0.0207)	(0.0314)	(0.00722)	(0.0175)
Quarter 3	0.0759**	0.0802**	-0.00676	-0.0228*
	(0.0291)	(0.0370)	(0.00725)	(0.0129)
Quarter 4	0.0644**	0.112**	0.000106	-0.0248
	(0.0278)	(0.0428)	(0.00917)	(0.0166)
		Small Banks and Post-Policy		
Quarter 5	0.125***	0.128***	0.0846***	0.0778***
	(0.0250)	(0.0355)	(0.0104)	(0.0147)
Quarter 6	0.159***	0.163***	0.0954***	0.0708***
	(0.0300)	(0.0522)	(0.0100)	(0.0197)
Quarter 7	0.153***	0.322***	0.119***	0.0442**
	(0.0355)	(0.0585)	(0.0114)	(0.0185)
Quarter 8	0.143***	0.418***	0.143***	0.0253
	(0.0254)	(0.0441)	(0.00910)	(0.0166)
Quarter 9	0.156***	0.402***	0.150***	0.0530***
	(0.0232)	(0.0354)	(0.00688)	(0.0138)
Quarter 10	0.196***	0.380***	0.147***	0.0292
	(0.0283)	(0.0503)	(0.00943)	(0.0205)
Quarter 11	0.208***	0.472***	0.162***	0.0494***
	(0.0310)	(0.0592)	(0.0106)	(0.0175)
Quarter 12	0.245***	0.565***	0.181***	0.0609***
	(0.0259)	(0.0448)	(0.0106)	(0.0180)
		Big Banks		
Big Bank × Quarter 2	0.105	0.213	0.0143	0.0341
	(0.109)	(0.173)	(0.0146)	(0.0356)
Big Bank × Quarter 3	0.0644	0.0104	0.0123	0.0288
	(0.170)	(0.302)	(0.0182)	(0.0348)
Big Bank × Quarter 4	0.0836	-0.0683	0.00168	0.0570
	(0.258)	(0.363)	(0.0331)	(0.0530)

Table 1: (continued)

Variables	(1) Deposits Ln Mill. Birr	(2) Lending Ln Mill. Birr	(3) NBE bills Asset Share	(4) Safe assets Asset Share
	Big Banks and Post-Policy			
Big Bank × Quarter 5	0.230	0.205	-0.0136	0.000138
	(0.169)	(0.165)	(0.0218)	(0.0271)
Big Bank × Quarter 6	0.367**	0.362	-0.00237	0.0377
	(0.183)	(0.225)	(0.0220)	(0.0487)
Big Bank × Quarter 7	0.445**	0.386	-0.00522	0.00537
	(0.181)	(0.258)	(0.0239)	(0.0379)
Big Bank × Quarter 8	0.507**	0.379	-0.00972	-0.0266
	(0.219)	(0.289)	(0.0282)	(0.0481)
Big Bank × Quarter 9	0.598***	0.430***	-0.00843	-0.00187
	(0.156)	(0.155)	(0.0186)	(0.0256)
Big Bank × Quarter 10	0.665***	0.586**	-0.00542	0.0375
	(0.186)	(0.248)	(0.0233)	(0.0428)
Big Bank × Quarter 11	0.706***	0.601**	-0.0134	-0.0143
	(0.192)	(0.284)	(0.0250)	(0.0385)
Big Bank × Quarter 12	0.759***	0.573*	-0.0323	-0.0423
	(0.228)	(0.303)	(0.0304)	(0.0473)
Quarter FE	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes
Bank × Quarter FE	Yes	Yes	Yes	Yes
Observations	512	512	512	512
Adj. R sq.	0.951	0.875	0.893	0.384
Mean Dep. Var.	7.751	7.295	0.0940	0.252
S.D. Dep. Var.	1.574	1.150	0.0736	0.0703

Note: This table reports OLS estimates; the unit of observation is bank level and bank and bank × quarter fixed effects are included. Standard errors are clustered at Bank × Year. Total deposits is a variable aggregating demand, saving, and time deposits at bank level; it is continuous and measured in million birr. Private lending embodies lending to the private (no financial sector, no public sector, regions, cooperatives) at bank level; it is continuous and measured in million birr. NBE bills is the amount of bills issued by the NBE at bank level; it is continuous and measured as a share of total bank assets. All liquid assets is the amount of liquid assets held by banks in cash, bank-to-bank deposits, and reserves at the NBE and NBE bills; it is continuous and as a share of bank assets. The variables are made intertemporally comparable using the core inflation figures from National Bank of Ethiopia (2012, 2013, 2014) and all figures are in real million birr, constant at 2010 prices. The means and standard deviations of these variables are reported in the last tow rows of the table. All of these variables are regressed over 13 quarter dummy variables, which span all the months in our data. The policy change occurs in Quarter 5 (April, May, and June 2011). These regressions measure the quarterly evolution, and an interaction of these dummies with the big bank dummy, to verify whether bigger banks are differentially affected by the policy, as Proposition 2 states. The reported coefficients show that the interaction between the big bank dummy and the period dummy cannot be rejected to be different from zero before the policy, while it is rejected afterward. Figures 5 and 6 plot all the coefficients over time. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

steady growth, which differentially affects more big banks. The same reaction is also exhibited by private sector lending, however this becomes statistically different from the small bank trend only after 2-3 quarters, as shown by Table 1.

Therefore, consistently with the theoretical model, an increase in safe asset holding by all banks generates a differential expansion in deposits and loans, stronger for larger banks.

2.2.2 Evidence from a Branch Map of Ethiopia

In this section, we present further evidence on a key feature of Propositions 1 and 2, where we show that the 27% rule is associated with greater branch expansion. In order to test this hypothesis, we construct a map of all branches in Ethiopia, where for each bank we know all the branches installed, their region and city of introduction with the month and year of opening. Our map covers 2,023 branches, installed by all 14 banks registered until 2013 and opened between 2000 and 2015. The Annual Report by the NBE in 2014 counts 2,208, and therefore our map considers more than 90% of existing branches.

In this analysis, we want to verify two features: 1) the overall number of branches increases as the liquidity effect kicks in, as the model predicts; 2) new branches are more "rural". We define a branch as "rural" if it the first to be opened in a town, which previously had no bank branches - considering this as a proxy of expansion into rural areas. Because our map explores all geographical features, we can see how many branches are opened in previously unbanked areas and therefore we can rely on this as the most reliably measure of bank ruralization.

For this reason, we run two tests, collapsing our branch-level database to a panel at bank level with months and year. The first test is a typical difference in difference regression

$$v_{ity} = a + b \cdot Policy_{ty} \cdot Big\ Bank_i + \iota_i + \iota_{ty} + \epsilon_{iy}, \tag{3}$$

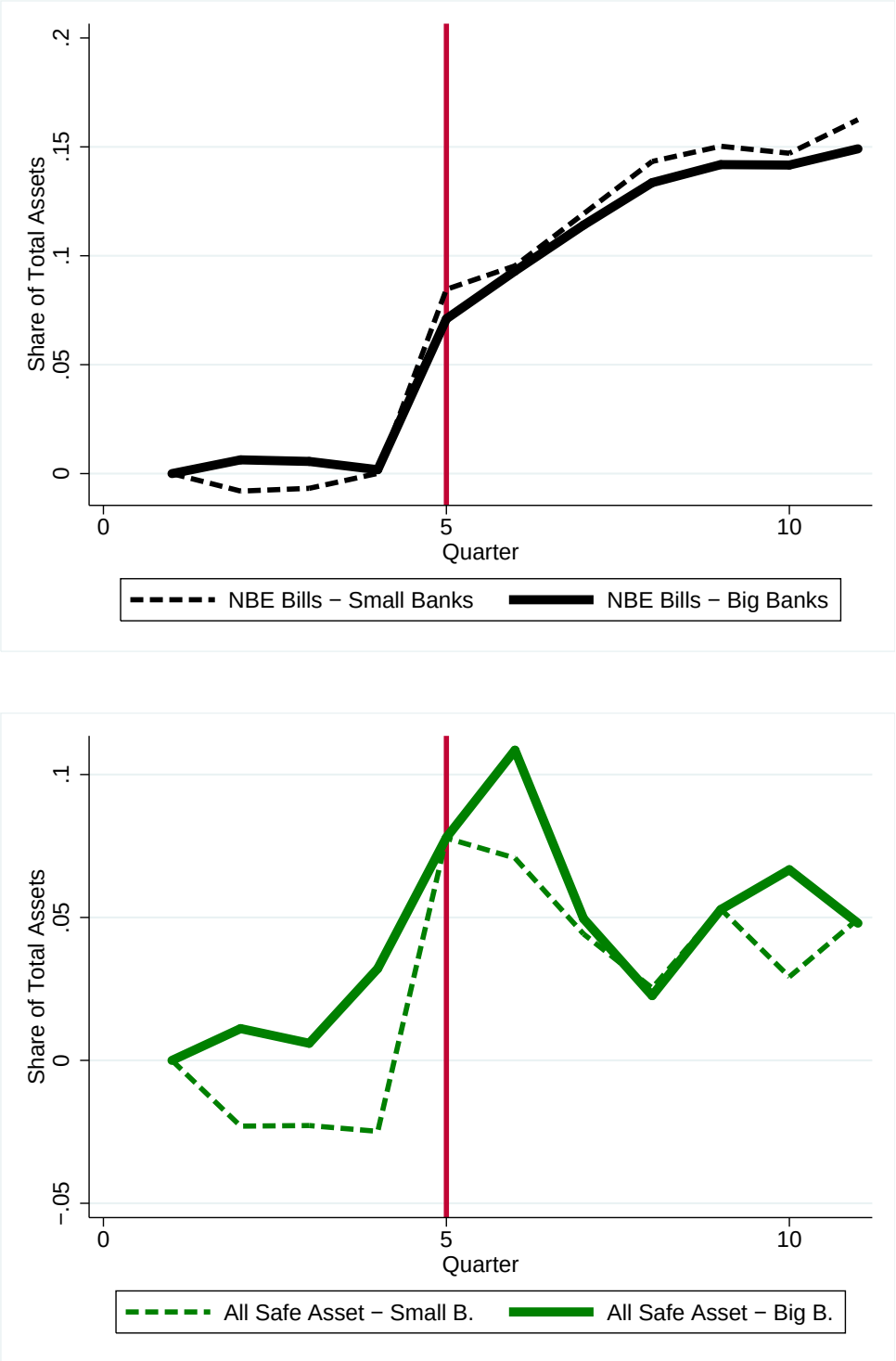
where the number of branches and the number of branches in previously unbranched areas, v_{ity}, are regressed over bank and month-year fixed effects and the interaction between a policy dummy taking unit value after April 2011, the introduction of the 27% rule, and the big bank dummy variable.

With the second test, we run the same variables over a series of yearly dummies, ι_y, which describe the branch accumulation trend for small banks

$$v_{iy} = a + \sum_y b_y \cdot \iota_y + \sum_y c_y \cdot \iota_y \cdot Big\ Bank_i + \iota_i + i_m + \iota_y + \epsilon_{iy}, \tag{4}$$

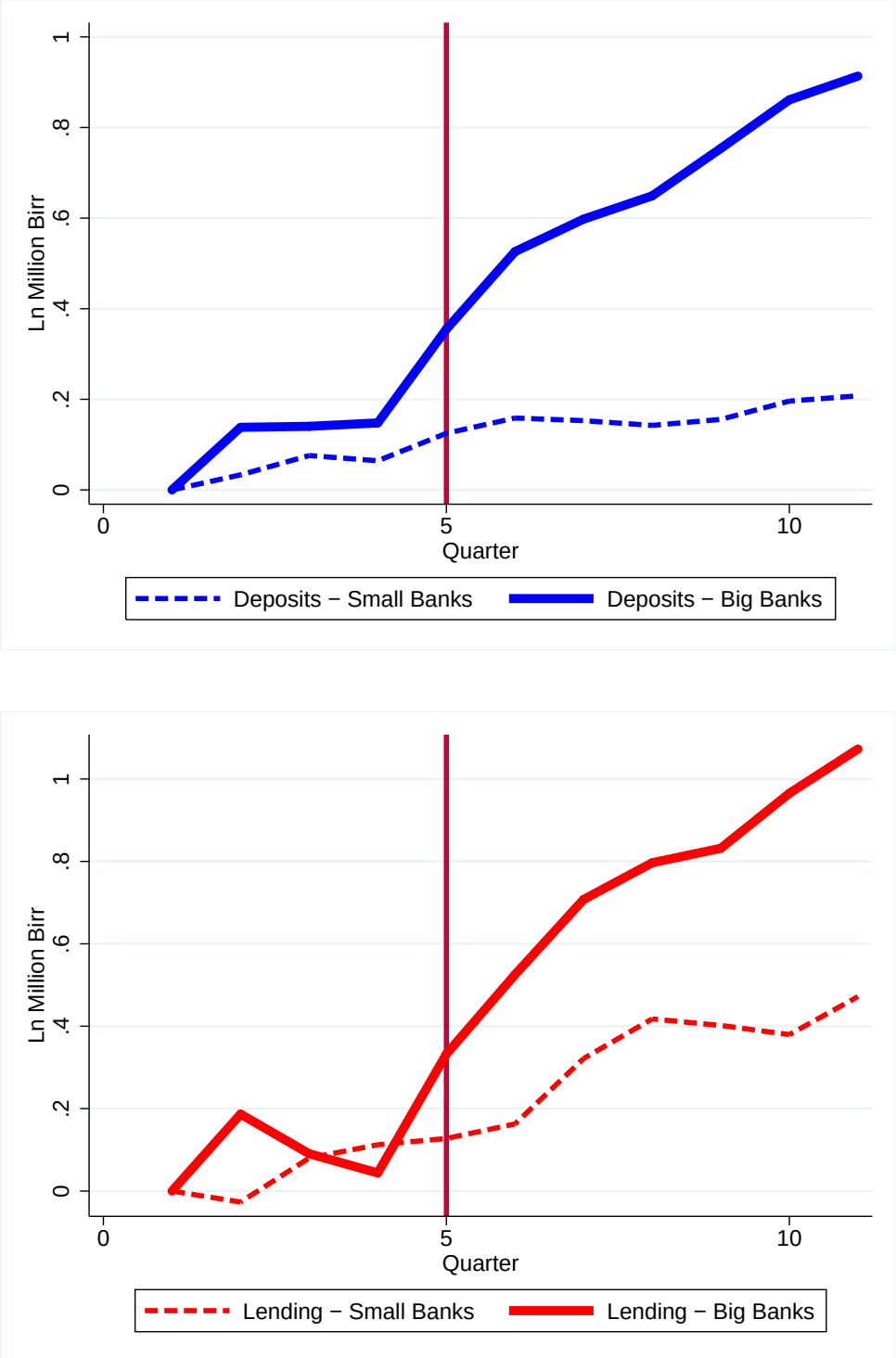
and an interaction of these with the big bank dummy, which describe the differential branch expansion of big banks. Table 2 reports that in line with our expectation, after the policy each big bank opened 10 branches more than the other banks, and they also accelerated rural branching, as big banks opened 2.5 additional branches over small banks in previously unbanked areas. Comparing these values with the mean dependent variable row, these magnitudes are

Figure 4: Policy Change and Trends: Deposits and Loans



Note: This figure plots the coefficients of the overall trend exhibited by small and larger banks for the asset share of NBE bills (upper panel) and the asset share of overall liquid assets (lower panel) over all quarters available in the data (NBE bills in black and safe assets in green). Big banks are reported using a solid line, while small banks are reported with a dashed line. The policy is announced in mid-March 2011 and implemented in April 2011 (shown by the vertical red line). As is evident, there occurs an important discontinuity around the policy introduction (Quarter 5) and all banks start purchasing a large amount of NBE bills, with a significant increase in the amount of overall safe assets. As is evident from Table 1, the pre-policy trends are not statistically different from zero, while post-policy all of them are. It is notable that all banks, both big and small, become safer in response to the policy. Appendix F reports the same picture with 95% confidence intervals.

Figure 5: Policy Change and Trends: Deposits and Loans



Note: This figure plots the coefficients of the overall trend exhibited by small and larger banks for deposits (upper panel) and loans (lower panel) over all quarters available in the data (deposits in blue and loans in red). Big banks are reported using a solid line, while small banks are reported with a dashed line. The policy is announced in mid-March 2011 and implemented in April 2011 (shown by the vertical red line). As is evident, there occurs an important discontinuity around the policy introduction (Quarter 5) and larger banks respond substantially more than smaller banks by collecting more deposits and giving more loans. As is evident from Table 1, the pre-policy trends are not statistically different from zero, while post-policy the deposit trend differs almost immediately, while the loan trend only from Quarter 9 onwards. Appendix F reports the same picture with 95% confidence intervals.

Table 2: Branches and New Towns: Branch Map of Ethiopia

Variables	(1) Number of Branches	(2) Number of Rural Branches	(3) Cumulative Distance of New Branches from HQ
Policy × Big Banks	12.60***	3.677**	1,533**
	(2.604)	(1.418)	(622.2)
Bank FE	Yes	Yes	Yes
Time FE	Yes	Yes	Yes
Obs.	379	379	379
Adjusted R^2	0.943	0.925	0.886
Mean Dep. Var.	53.87	29.08	10,055
SD Dep. Var.	33.11	15.61	6,882

Note: This table reports OLS estimates. The unit of observation is bank level, and bank and month-year fixed effects are included. Robust standard errors are reported in parentheses. The number of branches is defined as the cumulative number of branches installed by a bank, while the number of rural branches is defined as the cumulative number of branches opened in towns previously unbranched. Their means and standard deviations are reported in the final two rows. These variables are regressed over the interaction of a policy dummy taking unit value after April 2011 and the Big Bank dummy previously defined. The adjusted R^2 of these regressions is also reported. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

substantial: branches grow for big banks 20% more than smaller banks and rural branches by almost 50%.

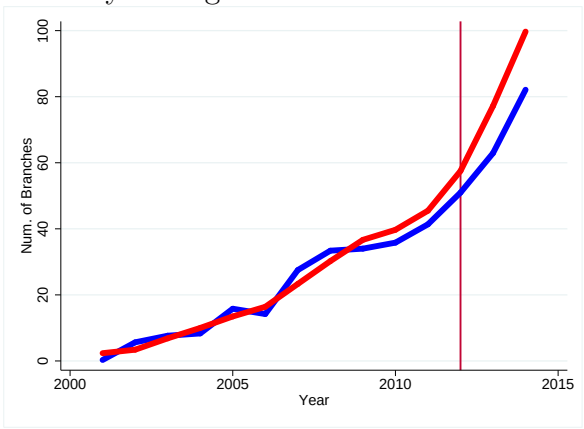
Figure 7 further explores this and shows the coefficients for big and small banks by describing their trends. The upper panel reports the evolution of branch installation; it is clear that up until 2012 the trends are indistinguishable, but they start to diverge after the introduction of the policy. Analogously, the lower panel shows a similar story for new branches opened in unbanked locations. Appendix F shows a test of the parallel trend hypothesis, showing that the differences between big and small banks were generally statistically different before the introduction of the policy, while after the introduction of the policy they became in line with the theoretical model.

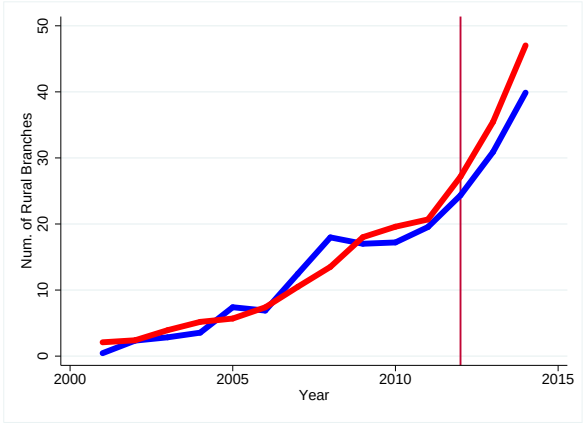
2.2.3 Evidence from Annual Reports

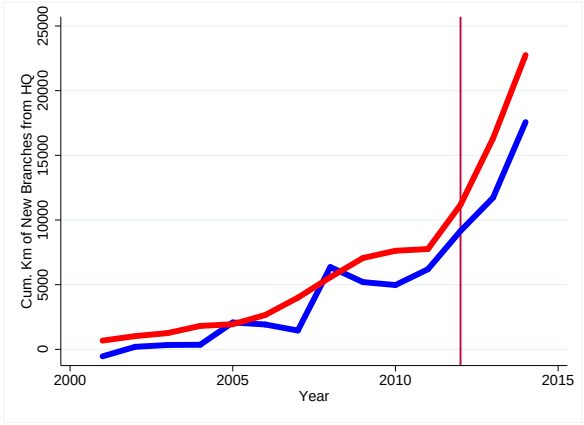
In this section, we present some supporting evidence concerning the non-negative effect of a shock to s on profits and its positive effect on the number of employees, as a proxy for size. Because these aggregates are collected yearly by banks, we lack the rich within-year variation, which has been exploited in the previous sections. Also, the number of observations becomes a big limitation, because now we only face a panel with five observations at most for each bank. However, we present two tests. The first is a simple difference-in-difference regression, where we verify whether profits and the number of employees grow more for larger banks than for smaller banks:

$$v_{iy} = a + b \cdot Policy_y \cdot Big\ Bank_i + \iota_i + \iota_y + \epsilon_{iy}. \tag{5}$$

Figure 6: Policy Change and Trends: Branch Installation







Note: This figure plots the coefficients of the overall trend exhibited by small and larger banks in overall branches and rural branches for big banks (blue) and small banks (red). The policy is implemented in April 2011 (shown by the red vertical line). As is evident, while branch accumulation does not differ before the policy change, afterwards big banks start to install more branches overall (upper panel) and more rural branches (lower panel). Appendix F reports the same picture, showing the difference with 95% confidence intervals.

Here, as usual, v_{iy} is a variable under observation for bank i in year y (note that the subscript t that refers to months is dropped as we deal with annual observations); this variable is regressed over the interaction, $Policy_y \cdot Big\,Bank_i$, which accounts for the differential effect of the policy dummy in big banks. The variable $Policy_y$ takes unit value for the fiscal years during which the policy has been in place (i.e., 2012 and 2013), while $Big\,Bank_i$ takes unit value for the big banks, as presented in Figure 4. These results are reported in Table 3 and show that big banks' profits grow more rapidly after the policy and the number of employees expands at a similar faster rate.

However, because difference-in-difference regression may present severe limitations in absence of parallel trends, we take a requires a test of the parallel trend hypothesis before the policy. For this reason, we present a second test by running the following regression,

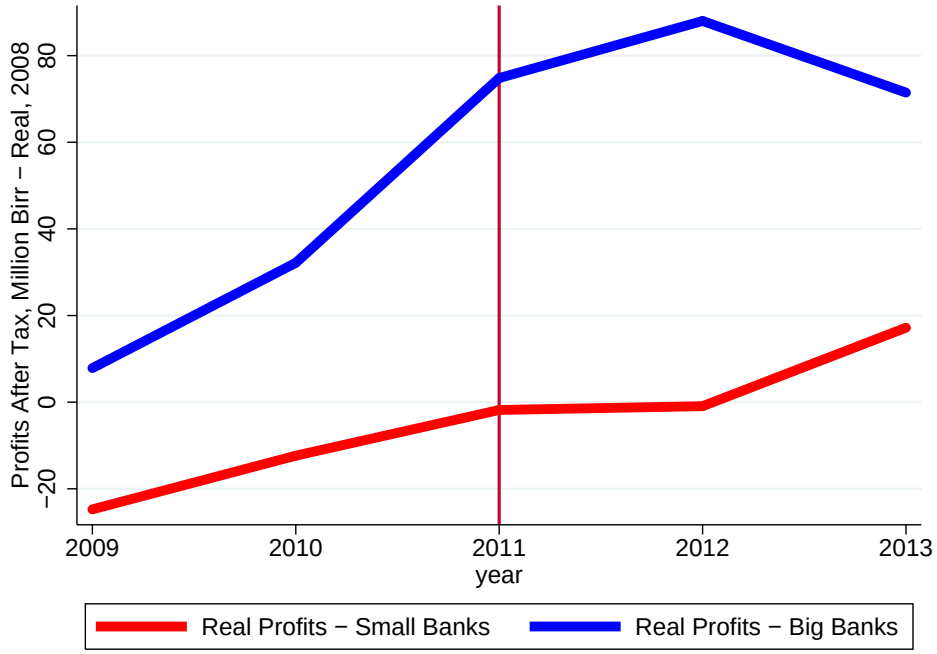
$$v_{iy} = a + \sum_y b_y \cdot \iota_y + \sum_y c_y \cdot \iota_y \cdot Big\,Bank_i + \iota_i + \iota_y + \epsilon_{iy}, \tag{6}$$

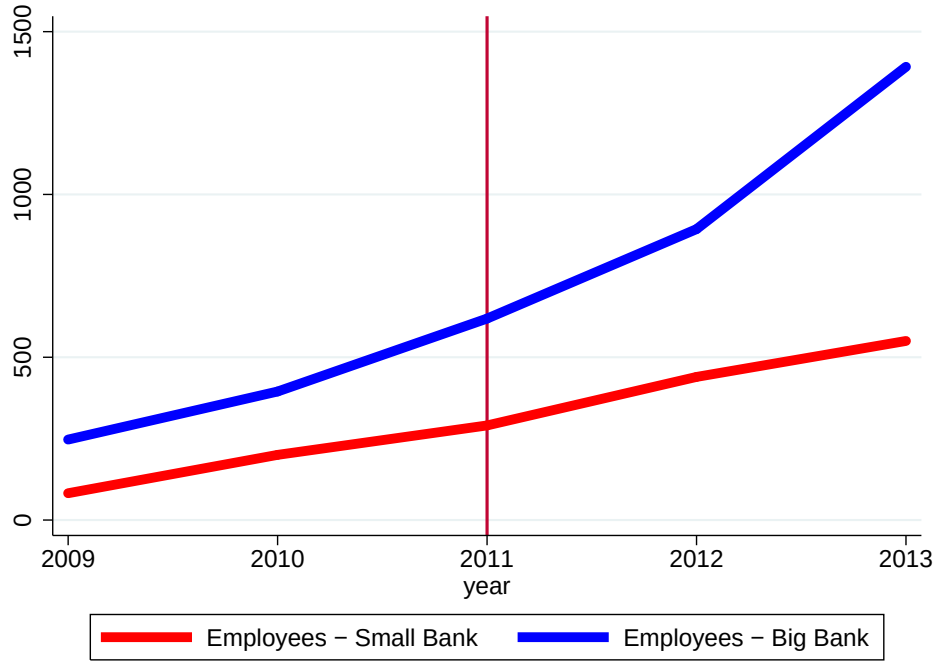
where real profits and number of employees are run over a series of yearly dummy variables, ι_y, which describe the evolution of profits and number of employees for small banks through the coefficients b_y and the interaction of yearly dummies with the big bank dummy, describing through the coefficients c_y their differential trend. As highlighted in Figure 8, there seems to occur a discontinuity at the introduction of the policy, both in real profits (upper panel) and employee numbers, supporting the previously reported hypothesis. In the next section, we clarify how these are in line with the evolution of branch installation.

2.3 Robustness Checks

In this section, we explore possible alternative explanations, which might be related to the policy change and invalidate our inference. The most important feature, which has not been previously addressed, is the destination of the funds collected by the NBE, through this new bill. One powerful argument regarding the effects observed in Figure 6 on deposits and loans could be the following. This liquidity regulation drained substantial resources from the banking system and placed them in long-term investment in some geographical areas to which big banks had a comparative advantage in access. In a sense, leaving aside the liquidity asset increase verified in Figure 5, this hypothesis would identify the regulation policy as an indirect transfer of resources from small to big banks. We believe this is implausible for two reasons. First, the Ethiopian government heavily relies on its state-owned bank, CBE, which is the largest in the country, not affected by the policy and profitable – in 2011/12, it amassed eight billion birr of profits, corresponding to roughly 400 million US dollars (USD). If there had to be a redistribution of resources, then the two state-owned banks (CBE and the Development Bank of Ethiopia, DBE) might have been the recipients, rather than private commercial banks. Secondly, if the argument given above is true, we should observe a special increase in credit and branches in those regions that were particularly targeted for long-term investment. The region that has mostly been attractive to long-term investment projects is Benishangul-Gumuz, which

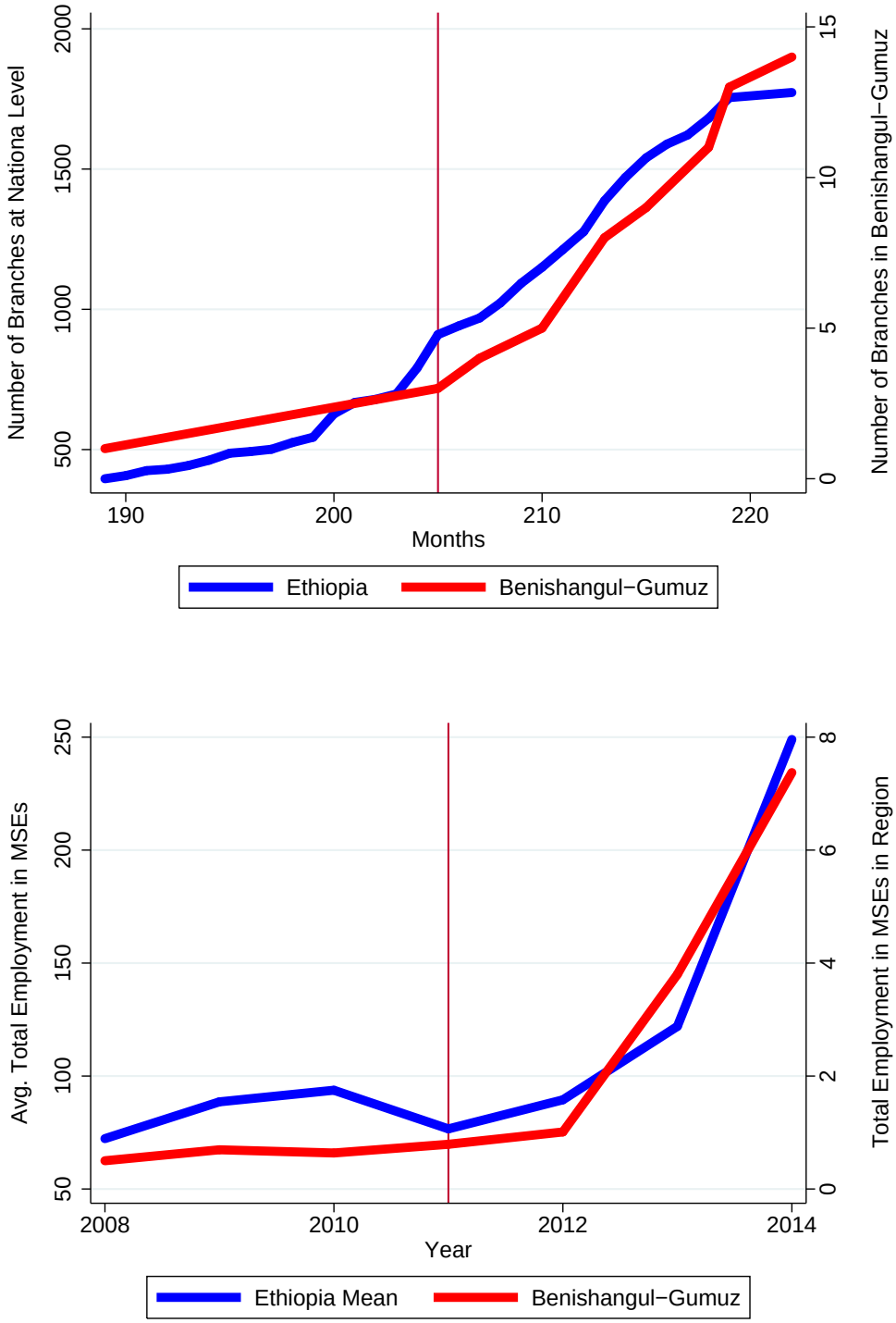
Figure 7: Policy Change and Trends: Real Profits and Number of Employees





Note: This figure plots the coefficients of the overall trend exhibited by small and larger banks in real profits and number of employees for big banks (blue) and small banks (red). The policy is implemented in April 2011 (shown by the red vertical line). As is evident, while both profits and number of employees do not differ before the policy change, afterwards big banks start to earn more (upper panel) and to hire more employees (lower panel). Appendix F reports the same picture, showing the difference with 95% confidence intervals.

Figure 8: Regional Heterogeneity



Note: This figure reports the monthly evolution of branch opening in the upper panel and the yearly total employment by medium-scale enterprises in the lower panel for the region Benishangul-Gumuz (in blue) and the other Ethiopian regions (in red). As is clear in both panels, there is no detectable difference between the rest of Ethiopia and Benishangul-Gumuz, which has been the center of substantial long-term investment in the last years. The upper panel reports the number of branches, while the lower panel gives the number of employees (in thousands). The red vertical line marks the month and year of the policy change (April 2011) in the upper panel and the year of the policy change (2011) in the lower panel.

Table 3: Profits, Branches and Regulation: Annual Reports

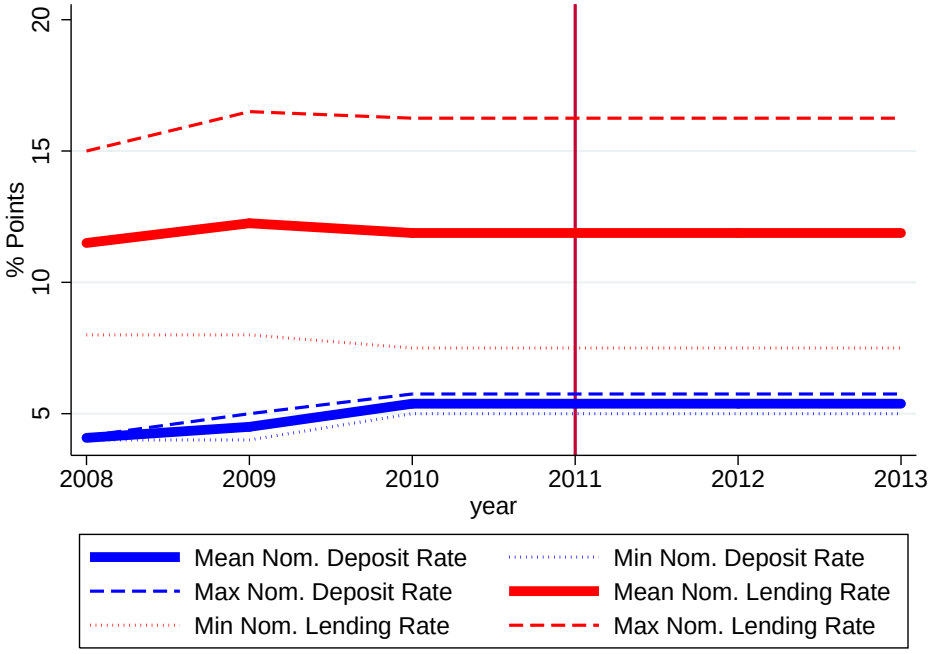
Variables	(1) Real Profits (million birr)	(2) Number of Employees
Policy × Big Bank	24.47*	393.3***
	(14.86)	(114.6)
Bank FE	Yes	Yes
Year FE	Yes	Yes
Observations	52	52
Adjusted R^2	0.938	0.971
Mean Dep. Var.	126.2	1,461
SD Dep. Var.	96.42	976.7

Note: This table reports OLS estimates. The unit of observation is bank level, and bank and month fixed effects are included. Davidson and McKinnon (1993) robust standard errors are reported in parentheses, which for this case are more conservative than bootstrapped bank-level clustered. Real Profits is the difference between the asset-generated income and liability-induced costs after taxes; it is continuous and measured in million birr. The number of branches denotes the total number of branches as shown in banks' annual reports. The variables are made inter-temporally comparable using the core inflation figures from National Bank of Ethiopia (2012, 2013). Their means and standard deviations are reported in the final two rows. These variables are regressed over a Policy dummy, which takes unit value after the introduction of the regulation policy and a dummy for Big Banks, taking unit value for the six banks classified as large in Figure 4. Bank and Year fixed effects are included. The adjusted R^2 of these regressions is reported in the row "Adjusted R^2". ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

hosts the construction site of the Grand Ethiopian Renaissance Dam (GERD). In Figure 9, we can observe in the upper panel the branch installation and total employment by medium-scale enterprises compared to the national average. As is evident, it is difficult to argue that such a region has been the destination of most attention and, for this reason, we believe that our claim concerning the mechanism through enhanced bank safety cannot be dismissed.

Another core element that has been omitted in the analysis is the price response of the policy. The theoretical model took prices as given and was silent on ways in which the lending and deposit rates could respond to a shock in s^R. This might create alternative channels through which the liquidity regulation shapes the economic problem. For example, if the lending rate in the good state, R_G, grew in response to the policy (or the deposit rate R_D correspondingly declined), then the branch expansion effect could be entirely due to an increased profitability of the banking system, with liquid assets being a negligible component of the story. We decided to leave prices constant in the model because of anecdotal evidence from Ethiopian bankers on the lack of a price response due to competitive pressure, which was then confirmed in our data collection exercise. In fact, Figure 10 presents the mean lending and deposit rates with their respective minimum and maximum rates as published by the National Bank of Ethiopia (2013). Although some changes occurred in mid-2009, it is noticeable that over the period of the policy (2011–2013), rates are generally constant, at least in the first moment of their distributions and the respective supports. This is in line with the theoretical model, in which market prices were left constant over the policy change.

Figure 9: Policy Change and Prices: Lending and Deposit Rates



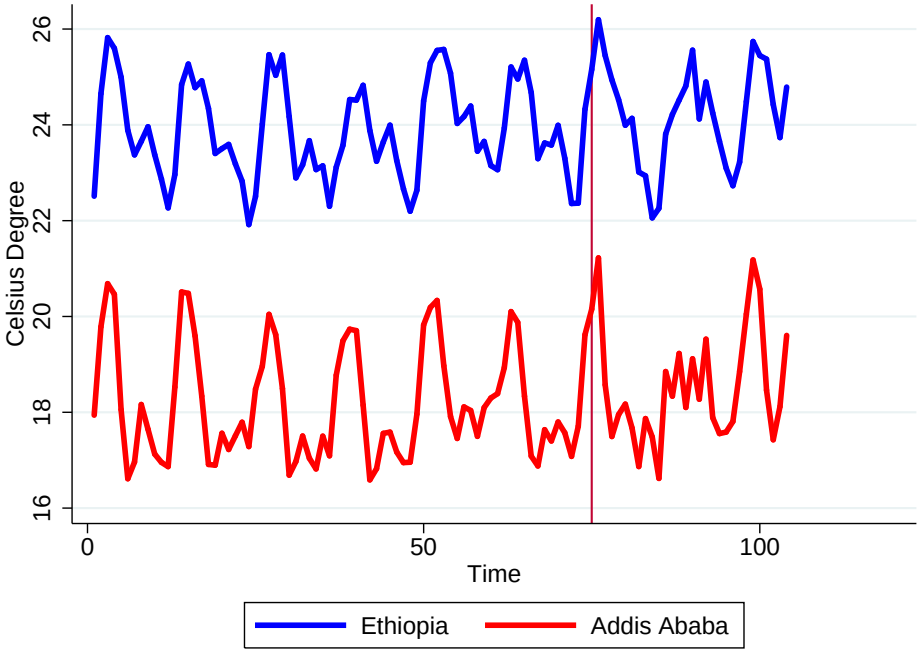
Note: This figure reports the monthly evolution of the average nominal deposit rate (blue) and lending rate (red), with their respective minimum and maximum rates. The sources are the 2012, 2013, and 2014 Annual Reports of the NBE. As described in the text, there is no detectable change in either rate in response to the policy change.

Thirdly, climate might be considered problematic, if the policy change occurred over periods of extensive temperature fluctuations, which might affect the agricultural and/or industrial productivity and hence financial markets. Ethiopia is a country with an heterogeneous climate, close to the equator and with diverse altitudes, all of these characteristics make it suitable for important temperature fluctuations, which might be related to our study. From an analysis of average monthly temperatures for Ethiopia (blue) and Addis Ababa (red) between 2005 and 2013, as shown in Figure 11, we observe that while there is some substantial cyclical variation in temperature, there does not seem to be an exceptional increase in either the level or the volatility of temperatures over the period of the policy change.

In addition to this, natural disasters might lead to a change in the marginal value of public/private infrastructure and affect financial markets. The year of the policy change, 2011, was indeed marked by one of the most severe droughts Eastern Africa has experienced in the past 60 years,[5] and this may be a reason for concern. As clarified by Figure 12, this disaster affected mostly Somalia, Kenya, and Ethiopia. However, this might be a limited concern for this study because while Somalia was hit in the most densely populated region of the country (around the capital city Modagishu), Ethiopia was hit in a low-density and predominantly rural area, as clarified by the lower panel of Figure 12. In particular, according to some controversial relief statistics, the number of Ethiopians affected by this disaster was between a few hundred

[5]Refer to the BBC article "Horn of Africa sees 'worst drought in 60 years'", 28 June 2011, available at `http://www.bbc.co.uk/news/world-africa-13944550`.

Figure 10: Climate and Policy Change



Note: This figure reports the monthly average temperature in Ethiopia (blue) and Addis Ababa (red) between January 2005 and August 2013. The policy change occurs in April 2011, Time 75, and there does not seem to be any response to weather changes. The data come from the Berkeley Earth project (`http://berkeleyearth.org/`). Alternative measures of temperatures were used from the National Oceanic and Atmospheric Administration (NOAA) National Climatic Data Center (NCDC), which are highly correlated with the current values (0.72 for Addis Ababa and 0.6 for Ethiopia) and highlight similar differences.

and 700,000,[6] which is a sizable number, but limited relative to the 2011 population of 89.39 million. In Table 4, we also report a list of the major disasters that have occurred in Ethiopia since 1960, and verify that this drought does not qualify as a disaster in the Emergency Events Database (EM-DAT) definition.[7]

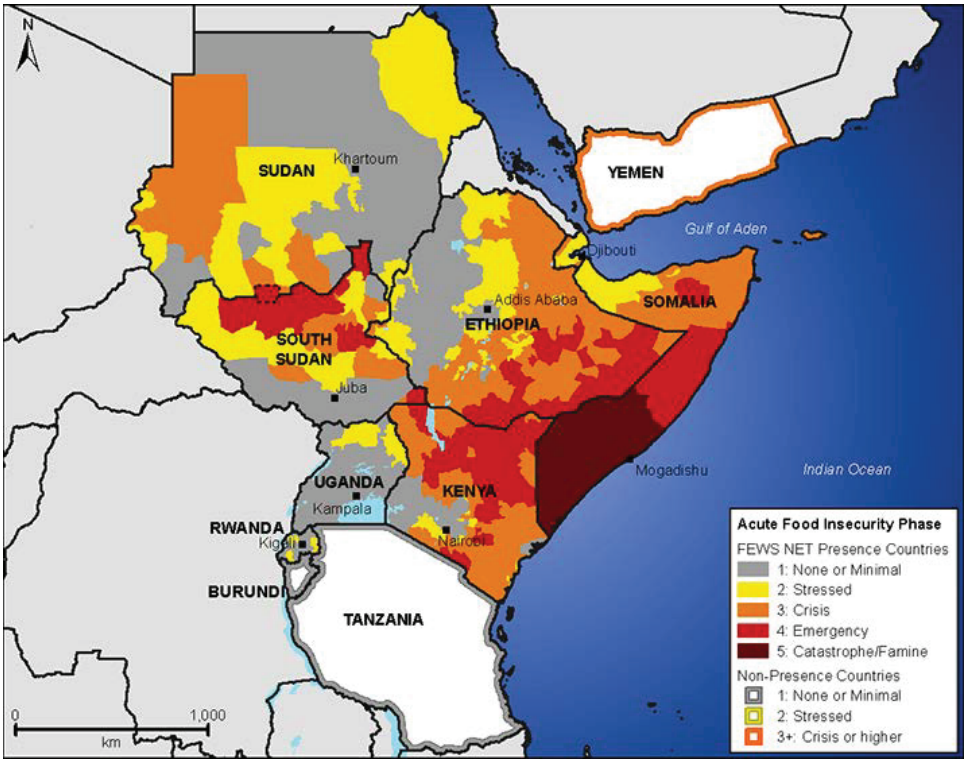
Last but not least, alternative policy changes might have contemporaneously affected bank behaviour. In this period, the introduction of interest-free banking (IFB)[8] is the most important regulation. This measure is meant to allow Muslim Ethiopians to have a deposit account, and invest in other financial products, complying with Islamic principles and not "making money with money". Because by law all deposits in Ethiopia are remunerated at least an annual 5%, this prevented the use of banking services by almost 33% of Ethiopians, which profess Muslim faith. As a result, this measure could have been a major confounder. For example, the simultaneous increase in deposits we observe may be mostly due to new Muslim customers, who might have been the driver of the effects. Even if this could be a fascinating hypothesis, we

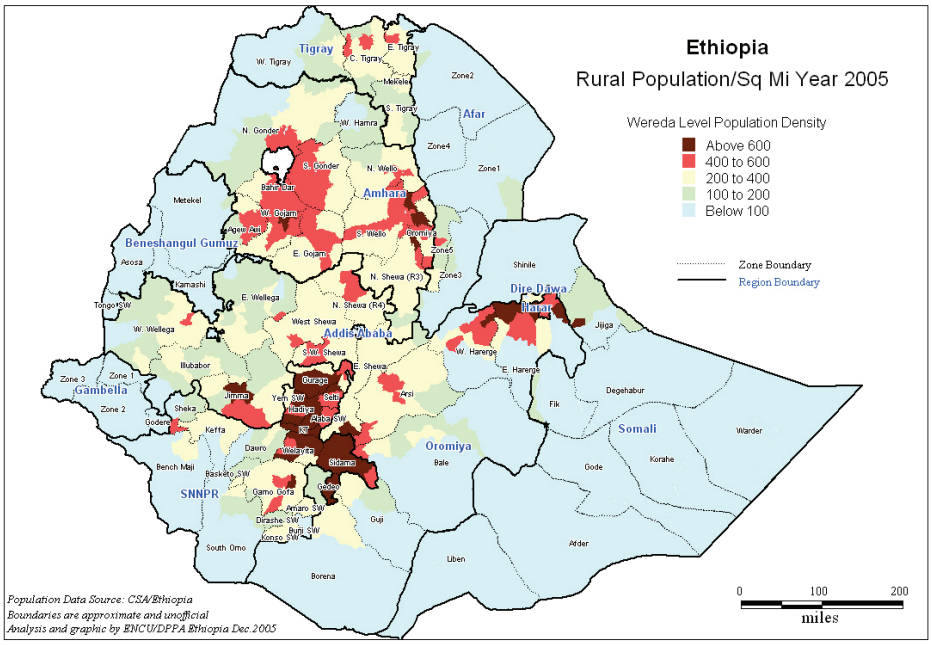
[6]Refer to the Huffington Post article "Ethiopia: Hunger During Worst Drought In 60 Years", 17 August 2011, available at `http://www.huffingtonpost.com/2011/08/17/ethiopia-hunger-drought_n_928989.html`.

[7]The EM-DAT is maintained by the Centre for Research on the Epidemiology of Disasters (CRED) and defines a disaster as an event satisfying at least one of these characteristics: "• Ten (10) or more people reported killed. • Hundred (100) or more people reported affected. • Declaration of a state of emergency. • Call for international assistance."

[8]For more information on this refer to the NBE directive available here `http://www.nbe.gov.et/pdf/directives/bankingbusiness/sbb-51-11.pdf`.

Figure 11: Drought and Population Density in Ethiopia in 2011





Note: The upper panel shows a picture of the 2011 Eastern African drought and the intensity at which countries were affected. The picture is based on the Famine Early Warning System (FEWS) and is freely available at `https://en.wikipedia.org/wiki/File:FEWS_Eastern_Africa_July-September_projection.png`. The lower panel shows a map of the population density in Ethiopia constructed by the Central Statistical Agency of Ethiopia (CSA). Comparing the two pictures, it emerges that the areas most affected by the drought were low-population density areas, mostly in the Somali and Oromiya region.

Table 4: Largest Disasters in Ethiopia

Type	(1) Date	(2) Total Deaths
Flood	13 August 2006	364
Flood	5 August 2006	498
Epidemic	September 1988	7,385
Drought	June 1987	367
Epidemic	January 1985	1,101
Drought	May 1983	300,000
Epidemic	January–December 1981	990
Drought	December 1973	100,000
Epidemic	January 1970	500
Drought	July 1965	2,000

Note: This table reports the most important disasters in Ethiopia between 1960 and 2015, from the most recent to the oldest. In recent years, Ethiopia has not experienced any disaster that could be related to the policy introduction. The data source is EM-DAT (`http://emdat.be`).

exclude IFBs are effectively responsible for any of the effects we report. Despite 2011 marked the legalization of IFB in Ethiopia, only one bank announced operations toward IFB at the end of 2013, which is the last part of our sample. A few other banks officially launched IFB products only in 2014 and 2015[9]. The reluctance behind this initiative is mainly given by the higher costs of operating these financial products, as the bank needs to directly purchase the investment good on behalf of the firm, which then progressively repays back.

3 Conclusion

In this paper, we show that liquidity regulation can promote bank deposits by imposing safe asset holding in the absence of deposit insurance and credible safe-asset commitment by banks. This is true if the regulation does not exceed a threshold below which the elasticity of deposit mobilization to liquidity regulation exceeds the elasticity of the profit margin and asset loan share to the regulation. Such policy can promote also bank lending and profits, if the decline in the profit margin is exceeded by the size of the balance sheet growth, caused by additional deposits flowing in as the financial system becomes safer.

The mechanism we describe relies on a key feature of the banking problem: the existence of a commitment problem between the bank and depositors. Depositors would like a liquid and safe bank, which fully repays their deposits; however, because deposits are given before the liquid asset allocation and the presence of limited liability, they anticipate low repayments in

[9]The first bank to offer IFB was Oromia International Bank in September 2013, while the state-owned Commercial Bank of Ethiopia announced operations at the end of October 2013. Successively, Wegagen International Bank, United Bank and Abay Bank announced the offer of IFBs in 2014, while the other banks are moving in this direction but have not yet implemented such products. For more information on this refer to the issue of October 2013 and May 2014 of Addis Fortune, a major Ethiopian business magazine: `http://addisfortune.net/articles/commercial-bank-to-launch-interest-free-banking/` `http://addisfortune.net/articles/interest-grows-in-interest-free-banking/`

a default and deposit less. Given these features, a regulation imposing the mandatory level of liquid assets generates two effects on the total loan volume and branch numbers: 1) a negative effect, which shrinks the profit margin in the branch, through the re-allocation from high yield (loans) to low yield (safe) assets; 2)a positive effect, by promoting deposits by households in existing branches, and hence expanding the assets of the bank. The positive effect can dominate the negative effect, especially if the financial sector is risky and does not present deposit insurance, and hence there are large gains from a "stabilization policy" for depositors.

Given these theoretical results, we test the predictions of our model exploiting the introduction of a new liquidity regulation in Ethiopia in April 2011. This case study offers a unique feature, which is key to our identification: a large and unexpected policy change, which boosted the liquid holdings by banks by 25% in one quarter. This is combined with four special features that allow our analysis: balance sheets at monthly frequencies, which allow us to tightly track the policy change; distinct cross-sectional variation in asset size across Ethiopian banks, which contributes to a neat identification; a long-term branch map covering installations in the last 15 years; and annual report digitization for five years around the policy. Combining the time-series variation generated by the introduction of the policy, with cross-sectional variation in bank size, we find that banks exposed to this policy do not lose profits, accumulate more safe assets, and increase their deposits and loans.

These results shed light on an alternative role of liquidity requirements which has not received empirical consideration. Our findings are particularly interesting for emerging markets, which share many financial institutions and characteristics in line with Ethiopia. At the same time, this mechanism may also apply to financial systems in high-income countries, which encounter temporary systemic shocks which simultaneously weaken the credibility of government guarantees (i.e. deposit insurance) and the solvency of banks.

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Chapter 3 - Financial Regulation and Government Revenue: The Effects of a Policy Change in Ethiopia*

Nicola Limodio† Francesco Strobbe‡

April 2017

1 Introduction

Financial regulation policies which promote, or impose, the purchase of government bonds give rise to a fiscal policy dimension. Reinhart and Rogoff (2009) and Reinhart, Reinhart, and Rogoff (2012) find historically that even if in principle "macroprudential regulation need not be the same as financial repression, [...] one can often be a prelude to the other". In this paper we investigate two core questions relating to these issues. (1) How much government revenue can financial regulation produce? (2) Through which channel does financial regulation generate government revenue? We show that the revenue gains can be moderate, using as a specific piece of regulation in Ethiopia as an unexpected policy change, and highlight that government revenue is created by transferring banks profitability without negative consequences on overall intermediation.

A sizable body of literature has calculated the government revenue gains from macroprudential regulation, or financial repression, adopting a variety of methods: the most popular uses a weighted spread between foreign and domestic interest rates (Giovannini and De Melo 1993), while others consider the presence of large reserve requirements combined with an inflation tax (Fischer 1982; Brock 1989; Agénor and Montiel 2008). Such a line of research has provided considerable insight into government intervention in financial markets across countries and, implicitly, into countries' financial development. However, most of these estimates rely on a direct link between government policies and the main aggregates (i.e., the foreign-domestic spread, actual reserve requirements), which cannot be tested because of various identification concerns. This makes the revenue gain calculation unclear, as the policy may not actually induce any

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real change in the economy. For example, a country may impose large reserve requirements because of budgetary pressures during an increase in systemic risk (i.e., an international debt crisis, a recession). However, such requirements may not bind as banks might already have been holding substantial reserves anyway. For this reason, assuming that reserve requirements are policy-driven, then some revenue calculation is still feasible, while in practice these policies have no direct effect on revenue. Analogously, the spread between foreign and domestic interest rates can largely be attributed to household preferences for domestic investment, in line with the Feldstein–Horioka puzzle (Feldstein and Horioka 1980), rather than regulation. Therefore, while most of the literature relies on cross-country analysis and assumed linkages, we take a more direct path.

We advance this literature and contribute to the calculation of government revenue gains by tracking the micro-level evidence through which financial regulation leads to government revenue gains. We propose a direct calculation of such savings based on credible counterfactuals. In this paper, we focus on a specific case study: the introduction of a financial regulation policy in April 2011 by the National Bank of Ethiopia (NBE) on all private banks. This regulation is ideal for the purpose of our study for a variety of reasons. First, the policy was announced and implemented with short notice (in mid-March 2011 and April 2011, respectively) and banks were largely surprised by this. Second, the magnitude of the regulation was substantial, as it imposed the purchase of 0.27 bonds issued by the central bank (NBE bills) for every unit of loans extended to the private sector. Third, banks would not be willing to hold these bills in absence of the regulation, because these present a fixed nominal rate of 3% and deliver an effective negative net return[1]. Therefore, both the regulated mandatory quantity of bond purchase and their price are fixed.

By having access to data on monthly balance sheets of all Ethiopian banks, to a disaggregated survey of branch installation costs, and to annual reports, we are able to verify how the policy affects bank behavior and to calculate the government revenue gains induced by the policy. This paper advances this body of literature through two fundamental innovations. First, we provide a country-specific government revenue calculation based on a clear policy, for which we can verify its effect on the regulated entity (banks and their balance sheets) and calculate the revenue gains. Secondly, we benchmark this policy against three alternative and credible ways of raising revenue through the banking system. Despite methodological changes, our results are essentially in line with the literature[2], however rather than a macroeconomic approach we follow a micro-oriented calculation as suggested by Siegel (1981).

We find that this policy creates a moderate revenue gain: depending on the counterfactual scenarios, such gain lies between 1.5% and 2.6% of the total tax revenue (this corresponds to 20% of all Personal Income Tax revenue in Ethiopia). In addition, we track the mechanism through which revenue is generated, and verify that diminished bank profits is the only aggregate

[1]In fact, while on the asset side each NBE Bill provides a 3% remuneration, the core liability of Ethiopian banks (deposits) are remunerated, on average, at 5.5% and at least 5% by law. Therefore every NBE Bill delivers to the bank a net negative return between 2% and 2.5%.

[2]In fact, in Appendix D we show that our results are consistent with the methodologically alternative calculations of the financial repression revenue introduced by Giovannini and De Melo (1993).

affected, with an undetectable pass-through on borrowers or depositors[3]. At the same time, we observe that banks comply with the policy by purchasing the NBE bills as prescribed and increasing their overall safe asset holding. The quantitative effects on bank profitability are sizeable: bank profit growth declines from a 10% yearly rate pre-policy to a 2% post policy.[4] Therefore, overall, while we do not take a clear stance in favor of or against the policy, our results provide robust evidence on the relation between financial regulation and government revenue generation, showing that lowering bank profits is the channel through which this takes place.

In Section 2, we present an essential review of the literature on this topic. In Sections 3 and 4, we introduce and discuss the Ethiopian financial sector and the regulation policy. Finally, in Section 5, we offer some concluding remarks.

2 Literature Review

The literature on financial repression dates back to McKinnon (1973) and Shaw (1973), who coined the term "repression" for policies that distort the allocation of capital by draining financial resources toward the government. These authors were mostly describing the phenomena behind financial repression and relating them to liberalization, in a context in which centralized economies were the alternative economic system. Specifically, financial repression is defined through policies that depress the deposit rate and, consequently, the aggregate amount of savings.

Giovannini and De Melo (1993) moved the attention of this literature from a descriptive approach to revenue calculation. They exploited the spread between foreign and domestic interest rates in a sample of 24 countries to calculate the government revenue from financial regulation and showed that these can be sizable: on average, 2% of GDP or 9% of total government revenue. Using as a comparison the work of Fischer (1982), who calculated the inflation-led seigniorage revenue from mandatory bank requirements, Giovannini and De Melo established a parallel between the two and found these alternative revenue sources to be equivalent in magnitude. An analogous exercise has been performed by Brock (1984, 1989), and recently Agénor and Montiel (2008), who also focus on the gains generated by imposing large reserve requirements and an inflation tax. In terms of optimality of financial repression and seigniorage taxes, Bacchetta and Caminal (1992) analyze the effect of financial integration for countries relying on the taxation of their domestic financial system. They relate financial liberalization to reserve ratios, inflation rates, and government debt, and propose a model to explain the setting of the optimal seigniorage tax. Their findings show that liberalization can be detrimental for welfare under some conditions and that reserve ratios can be increased prior to liberalization,

[3]In a companion paper (Limodio and Strobbe 2016), we have shown that, counterintuitively, deposit and lending rates do not respond to the policy and the aggregate level of deposits and loans do not decline, while banks start to expand because of the additional safety provided by the policy.

[4]The desirability of this result is ambiguous in terms of welfare, given that the Ethiopian banking sector registers an exceptional profitability: the local average returns on equity stand firmly at 55% (IMF 2013), above the African (30%; IMF 2013) and Western (5%; Schildbach and Wenzel 2013) averages.

this results recall the assessment of Sussman (1991). A similar conclusion is achieved by Mourmouras and Russell (1992), whom consider a the role of optimal reserve requirements rather than a direct taxation of the banking system to finance government expenditure. On an analogous line, Espinosa-Vega (1995) shows that the introduction of a traditional multiple reserve requirement be both welfare enhancing and inflation minimizing compared to a single reserve requirement regulation.

Two papers document the experience of two leading Asian countries – South Korea and China – which implemented substantial financial regulation policies in their key years of growth. Demetriades and Luintel (2001) provide empirical evidence on the effects of financial restraints on South Korean financial development. In an essential theoretical model, they show a positive association between financial development and the degree of state control over the banking system, and a positive relation between financial development and mild repression of lending rates. These results are validated in their empirical analysis, in support of a role for financial regulation policies. Huang and Wang (2011) examine the impact of financial repression on economic growth during China's reform period. They document the existence of an inverse U-shaped relation between financial repression and growth in the Chinese experience: positive for low levels and negative for higher levels.

On a finer historical basis, Reinhart and Sbrancia (2011) provide a comprehensive account of the main financial regulation tools and their application in the last century, focusing especially on calculating the "financial repression tax" in a case where the government both caps the interest rates and creates a "captive" domestic audience for its debt. Reinhart, Kirkegaard, and Sbrancia (2011) document the resurgence of financial repression in the wake of the 2007–2009 financial crises and the accompanying surge in public debts in advanced economies. Their conclusions point to financial repression being particularly successful in liquidating debts when accompanied by a steady dose of inflation.

In exploring this policy, we participate in the debate on the tools for public debt reduction and promote a moderate degree of financial regulation as a viable solution. A body of recent literature (e.g., Aizenman and Marion 2011; Cochrane 2011; Davig, Leeper, and Walker 2011) supports the view that inflation will emerge as a consequence of fiscal imbalances and will be the long-term solution to lowering public debt. However, Hilscher, Raviv, and Reis (2015) conclude that financial regulation, or regulation coupled with inflation, can be more effective to lower the real value of public debt, in line with Reinhart, Kirkegaard, and Sbrancia (2011). They find that forcing banks to hold a special lower-yielding bond may be a solution, which is analogous to the policy under study in this paper. Concerning this case study, we show that the revenue gains of such policies can be moderate, while the costs on the banking sector may be negligible in terms of profitability and intermediation.

3 Ethiopian Banks and Policy Change

In this section, we present the effects of a new financial regulation on banks and verify their behavioral response to the policy. As discussed in the introduction, this is key to establishing a direct link between bond purchase and the regulation, which then permits us to calculate the government revenue gains. We exploit the introduction of a significant policy change in the Ethiopian financial sector that occurred in March 2011, when the NBE issued a directive requiring all private commercial banks to hold 27% of new loan disbursements in negative-yield NBE bills. This policy can be described as a typical macroprudential regulation measure because it imposes safe asset purchase. At the same time, this also creates a "regulation tax" on banks, given that the average deposit remuneration is 5.5% (National Bank of Ethiopia 2012), with a legal minimum of 5%, which implies that on each NBE bill, banks lose a net 2–2.5%. In essential terms, this policy regulates both the mandatory quantity of purchased bills (27% of new loans) and their price.

The relevant aspect of studying the so-called 27% rule is given by the unique nature of this shock, because it was unexpected, it was announced less than a month before implementation, and it was large, with banks mobilizing a large part of their assets in response to the policy. In another paper on the same policy, Limodio and Strobbe (2016) show that this safe-asset policy leads to a substantial balance-sheet expansion and provides a clear theoretical underpinning and identification of the effect.

In this section, we discuss three issues that are useful in our accounting exercise:

1. compliance – banks responded by purchasing NBE bills as prescribed by the regulation (Table 1);

2. safety – overall safe asset purchase increased one-to-one with the NBE bill purchase (Table 2 and Figure 1);

3. profitability – banks' profit growth slowed down, but did not turn negative (Table 3 and Figure 2).

Compliance

In this subsection, we show that banks started to purchase this bond in proportion to lending $(0.27 : 1)$ as prescribed by the regulation. For this task, we use the monthly bank balance-sheet information and present a simple fixed effect regression, highlighting that the policy had an actual effect on the behavior of private banks. For this reason, we use the volume of NBE bills purchased by bank i in month m and year y,

$$NBE\ Bills_{imy} = a + b \cdot Policy_{my} \times Lending_{imy} + \iota_i + \iota_m + \iota_y + \epsilon_{imy}, \tag{1}$$

and regress it over a dummy variable taking unit value after April 2011, $Policy_{my}$, interacted with the monthly bank-specific volume of lending, $Lending_{imy}$, and bank, month, and year fixed

effects. The null hypothesis of this test is $b = 0.27$, given the 27% rule. In the presentation of the main results, we exploit a variety of variations by including and excluding certain sets of fixed effects. Under no circumstances can we reject that banks start purchasing the government bonds as prescribed by the regulation.

In Table 1, we report the results of regression (1) for the whole variation in column (1). We exploit only within-bank variation by including only bank fixed effects in column (2), and then by removing year-specific shocks in column (3) and month-specific shocks in column (4). Finally, we replace the last two with non-parametric effects for every month of every year in column (5). Though the point estimates move slightly across these estimations, the null hypothesis $b = 0.27$ can never be rejected and therefore it cannot be dismissed that compliance indeed took place. In Appendix A, we also present two other estimations in which we slightly change the main regression model, and the results are indeed unchanged. To verify also graphically that compliance occurred, in Appendix B we provide a figure showing the average balance-sheet composition across months and we verify the NBE bill purchase after April 2011.

Safety and Profitability

In this short subsection, we show that the regulation had two consequences: 1) an increase in the purchase of NBE bills; 2) an increase in the overall quantity of safe assets held by banks (i.e., cash, other liquid assets, government bonds, bank-to-bank deposits, central bank reserves). This is important, because unless banks change their actual asset allocation, then it may be argued that this policy overall generates only a change in safe asset composition (i.e., less cash and more government bonds). This, in turn, would classify this policy as a simple tax, rather a regulation altering the safe asset holding of banks.

To verify this, we exploit all available time series information and regress the two main variables (NBE Bills and Safe Assets) over all consecutive quarterly dummies (13 available) and bank fixed effects, as shown:

$$v_{it} = \alpha + \sum_t \beta_t \iota_t + \sum_i \gamma_i \iota_i + \epsilon_{it}. \tag{2}$$

In equation (2), the variable v_{it} (NBE Bills or Safe Assets) indicates the quantity of variable v for bank i in quarter t, and is regressed over quarterly dummies, ι_t, and bank fixed effects, ι_i. The former effects describe the average evolution of these variables over time, while the latter report the average quantity of specific assets held by a specific bank. The coefficients β_t from equation (2) are reported in Table 2 and plotted in Figure 1. By inspecting both, we can verify that with the introduction of the policy, the amount of NBE bills (in black) went from zero to roughly 500 million birr in April 2011 and kept growing steadily afterwards. At the same time, safe assets (which include NBE bills) increased one-to-one with this variable. This shows that the policy was successful in leading Ethiopian banks to become safer with the introduction of the policy, and banks did not substitute away from one type of liquidity (bank-to-bank deposits, cash, etc.) to NBE bills, but rather increased the overall aggregate.

Last but not least, we have referred to this policy as a macroprudential regulation as well as a "financial regulation tax". Indeed, we find that bank profitability suffers in the aftermath of this. For this purpose, we collect data from bank annual reports and run a similar regression to equation (2):

$$v_{iy} = \alpha + \sum_{y} \beta_y \iota_y + \sum \gamma_i \iota_i + \epsilon_{iy}. \tag{3}$$

The difference is that while balance-sheet variables (NBE bills, safe assets) are measured monthly, the profits are only measured yearly. Analogously to the previous subsection, we report the coefficients β_y of equation (3) in Table 3 and plot the yearly coefficients in Figure 2. By inspecting both elements, it emerges that the growth of profits significantly slowed as the policy came into existence. Between 2009 and 2011, profits grew by 11% yearly and this collapses to 2% between 2011 and 2013. Therefore, there is some evidence linking the policy to a decline in profit accumulation, without turning this negative.

4 Government Revenue and Policy Change

The regulation implemented by the NBE has been successful in establishing a market for NBE bills and in forcing the 14 local banks to comply with this new rule. In this section, we calculate the revenue gains from this, in line with the financial repression literature. At the end of the 2012 fiscal year, treated banks amassed a total of 13.976,75 million birr of NBE bills, corresponding to 702.43 million US dollars (USD). This number is in line with what media and the IMF reported.[5] How can we account for the revenue gains of this policy?

The objectives of the policy are twofold: to promote long-run investment and to enhance bank safety. Both objectives seem to be extremely difficult to quantify and they expose us to faulty predictions. Similarly, in a full welfare analysis, we would also need to account for the benefits and costs of this initiative: weighing the effect on firms and households, against government gains and bank performance. However, at the current stage, this would require considerable assumptions that we are not going to make. More modestly, we follow the government revenue literature and focus on accounting the savings on the interest rate relative to other policies. For this purpose, we need to propose alternative scenarios of how these funds could be raised and to establish their cost. The following three scenarios are considered.

1. Borrowing from international financial markets. In this scenario, the Ethiopian government sells its bonds at competitive international prices.

2. Diverting private lending from the Commercial Bank of Ethiopia (CBE). With this policy, the Ethiopian government forces the largest bank, owned by the government, to replace private lending with government bonds.

[5] See the article "Ethiopian Central-Bank Order May Mean More T-Bills, Less Lending" by William Davison, Bloomberg, February 26, 2013, available at http://www.bloomberg.com/news/2013-02-26/ethiopian-central-bank-order-may-mean-more-t-bills-less-lending.html.

3. Raising new deposits through the CBE. This would imply expanding the branch infrastructure and would dedicate all new resources to funding the government.

In the following subsections, we describe the three alternative revenue scenarios, and we estimate their cost and the revenue gains. In general, we find that imposing the NBE bill purchase on private banks generates a moderate revenue for the government, around 11–19% of the deficit and 1.5–2.6% of tax revenue, considering their respective 2011 levels of 8.220,19 and 58.980,8 million birr (National Bank of Ethiopia 2012).

In order to offer a comparison with the literature, in Appendix D we propose a calculation of the government revenue from financial repression, following the methodology introduced by Giovannini and De Melo (1993). Though their approach relies on national accounts, rather than bank balance sheets, we find that our results are consistent in terms of sign and magnitude. Beyond being a useful check of our methodology, we find this result to be useful in linking the macro approach on government revenue with the richer micro approach we employ in this paper.

4.1 Borrowing from International Financial Markets

Ethiopia stopped borrowing from international financial markets after the 1991–1999 years of debt restructuring and relief (Borensztein and Panizza 2008). After the recent decade of exceptional growth and development, in December 2014 it issued its first internationally traded sovereign bonds, which were favorably received and priced at 6.625%.[6] This is a comfortingly low rate, provided that only in May 2014, Ethiopia was assigned its first sovereign rating by Moody's.[7] and that this was a B1 rating, indicating it as a speculative trade with a high risk of insolvency.

The rating and first rate provide a useful benchmark for a counterfactual analysis, so that we can provide a few scenarios on rates that Ethiopia needs to charge in order to replace the 27% rule with international bonds. It is also useful to refer to the experience of its two neighboring countries, Kenya and Uganda, who also enjoy a B1 valuation from Moody's and have been successfully issuing sovereign debt bonds on international financial markets over the last five years.

- Kenya remunerated its 91-days Treasury Bills between 8 and 20% in the last auctions, held between June and July 2014, with an average of 9.5%.[8]

- Uganda, analogously, priced its 91-days Treasury bills at 9.5% in the auction of 25 June

[6]Refer to the *Financial Times* article "Investors pile into Ethiopia's $1bn debut debt sale," by Javier Blas, December 4, 2014 (http://www.ft.com/intl/cms/s/0/0efe83f2-7bbb-11e4-a695-00144feabdc0.html#axzz3pUUOSsou).

[7]Refer to the *Financial Times* article "Ethiopia receives first sovereign rating," by Javier Blas and Katrina Manson, May 12, 2014 (http://www.ft.com/cms/s/0/cb3a02ee-d9c7-11e3-b3e3-00144feabdc0.html#axzz3Cl8WopSH).

[8]Refer to the Central Bank of Kenya Treasury Bills Average Rates at https://www.centralbank.go.ke/index.php/treasury-bill/91-days.

2014.[9]

Therefore, considering Ethiopia's first bond price as a lower bound and the Kenya/Uganda rates as a plausible counterfactual, we can infer that a likely rate for its alternative bond, priced competitively on financial markets, would be 9.5%, with the following range [5%,14%] as observed by auctions for Kenya and Uganda. This provides a simple reference against which to measure the revenue gains:

$$Gain = (R_I - R_G) \cdot G.$$

Here, $R_I = 9.5\%$ (or 6% and 12% in the lower and upper bound cases, respectively) would be the price charged on international markets, $R_G = 3\%$ the current NBE bill remuneration, and G the volume of NBE bills. Overall, this gain totals 908.49 million birr per year (43 million USD), between 279.5 and 1537.4 depending on the possible interest rate range, which accounts for 11% of the deficit or 1.5% of tax revenue.

4.2 Diverting Private Lending from the Commercial Bank of Ethiopia

The CBE is the largest Ethiopian commercial bank and one of the largest in Africa. It has more than 800 branches, seven million account holders, and 18,000 employees: its assets at the end of the 2011 fiscal year amounted to 226.338 million birr, equivalent to 11.372 million USD. It is owned by the Ministry of the Economy and is a grand contributor to government public finances, its mission being to "realize stakeholders' needs through enhanced financial intermediation globally and supporting national development priorities".[10] In fact, after the NBE and the Development Bank of Ethiopia, it is the largest bank holding government bonds, with 3% of the total; as a reference, all other banks combined hold less than 1% (Ministry of Finance and Economic Development 2012).

From the CBE balance sheet for July 2012, we can see that the CBE holds no NBE bills, but government bonds for 2.414,029 and private sector lending for 20.365,691 million birr, with the remaining funds dispersed in other assets. In this subsection, we propose a simple counterfactual exercise, in which we calculate the revenue of the CBE when some of its private lending assets are redirected to the purchase of the 13.976,75 million birr of NBE bills imposed on private banks.

From official documentation (Ministry of Finance and Economic Development 2012; National Bank of Ethiopia 2012), we know the average interest rate on all assets reported in the third column of Table 4. Therefore, we can simulate this alternative scenario. In so doing, we are ignoring the cost of liquidating private lending and considering the cost of this measure to be negligible for single firms and aggregate economy. In Panel A, we report the current partial asset allocation between government bonds, private sector lending, and NBE bills. Regarding the returns of this assets, while government bonds and NBE bills present a fixed return of 1.5% and 3% respectively, official authorities report the interest rate on private sector lending for its

[9]Refer to the Results of the Treasury Bills Auctions by the Bank of Uganda https://www.bou.or.ug/bou/collateral/tbills_forms/2014/Jun/resultstbill_922.html.

[10]Refer to the CBE web site for more information, http://www.combanketh.et/AboutUs/CompanyProfile.aspx

average, for both upper and lower bounds. For this reason, we can also propose in this case a range of estimates for the CBE revenue. In order to be rigorous, we define the calculated revenue as "partial", because we are focusing on a subset of CBE assets. In Panel B, we present the experiment in which we fund the NBE bill amount with private sector lending and recalculate the partial revenue. Panel C presents the counterfactual profit difference, which is not partial as we are keeping all other objects constant: in the average interest case, forcing the CBE to purchase NBE bills and give up private lending would impose 1.257,91 million birr of losses per year (59.8 million USD), in the range between 628,96 and 1.851,92.

Considering losses on the CBE as missing yearly revenue on the Treasury, then we can see that this policy would be, on average, more expensive than emitting competitive bonds on financial markets, which would cost 908.49 million birr per year. Specifically, the gains from this initiative correspond to 15% of the deficit or 2% of tax revenue in 2011.

4.3 Raising New Deposits through the Commercial Bank of Ethiopia

In the previous subsection, we considered funding the purchase of 13.976,75 million birr of NBE bills by moving CBE's assets away from private sector lending – hence an asset reallocation measure. In this subsection, we study a liability expansion scenario, through which we simulate the CBE costs of raising fresh 13.976,75 million birr of deposits, used to fund the NBE purchase.

By the end of the 2012 fiscal year (July), the additional total collected in deposits in Ethiopian banks compared to 2011 amounted to 46,475.2 million birr, mobilized by 302 new branches. Therefore, we consider the average deposit collection per new CBE branch as the total average deposit collected per branch by the whole banking sector (i.e., 153.9 million birr). This plausibly overestimates the amount of newly collected deposits per branch, for at least two reasons. First, in the extensive margin of deposit mobilization (new branches) we are also including the intensive margin (more deposits from existing branches). Secondly, branch allocation may begin from the deposit-rich areas and then be expanded to poorer areas. However, for the purpose of this exercise, this implies an underestimation of the costs of deposit collection, leading to a lower bound on our estimate. Given the average deposit collection per branch, CBE would need to install 91 new branches to cover the new asset.

What is the cost of installing a new branch in Ethiopia? This figure clearly depends on a variety of factors, and in order to obtain an average figure, we interviewed all Ethiopian private sector banks and had access to data on their branch installation costs. In the course of this discussion, there emerged an average figure of 300,000 birr per month (14,000 USD), ranging between 100,000 and 500,000 birr depending on location, local labor market, services offered, transport infrastructure, security expenses, and several other factors. However, 300,000 birr per month is the closest empirical analogue to our reference because it catches all costs, including rents, local wages, utility bills, equipment, and so on. As well as interviewing banks, we tested the plausibility of this number by using the annual report data and inferred branch costs. In Appendix C, we present a detailed exercise, which backs out the average cost of a branch from the yearly operational expenses of the CBE between 2006 and 2012. In line with interviews

with private sector banks, we obtain an average cost of a branch of 303,000 birr. Given that the minimum business-lifecycle of a branch is five years to collect the peak deposit from a location, this makes the average total cost of branch 18 million birr (ranging between 6 and 30), and equivalent to 900,000 USD. Therefore the total cost of opening 91 new branches is 1,638 million birr (ranging between 546 and 2,730).

Similarly to the previous case, we can calculate the revenue gains on the Ethiopian Treasury, by subtracting the NBE bill interest payment from this liability expansion measure. This overall cost is composed of two components: a fixed cost, the installation of 91 new branches, BI; and a variable cost, which is the net loss incurred by the CBE on collecting 13.976,75 million birr of deposits remunerated at an average rate of 5.4% and their use for NBE bill purchase, which only give a 3% fixed return. Therefore, the final gain can be written as follows

$$Gain = BI + (R_D - R_G)G - R_G G = 1,638 + 335.5 - 419.3,$$

which places the revenue gains of introducing the NBE bills at 1,554.2 million birr (between 462.2 and 2,646.2). Overall, this gain is 24% higher than the previous gain and makes the savings of this measure 19% of the deficit and 2.6% of tax revenue.

5 Concluding Remarks

In this paper, we show that the government revenue gains of a specific piece of financial regulation in Ethiopia (the 27% NBE bill regulation) are moderate and that lower bank profits are the channel through which this revenue is created. In order to benchmark the government savings of imposing safe asset purchase on banks, we rely on three credible counterfactuals: 1) issuing a bond competitively priced on international capital markets; 2) raising revenue by diverting resources from the state-owned bank; 3) forcing the state-owned bank to raise new deposits and fund the same bond. Our calculations highlight that such savings lie between 1.5% and 2.6% of the tax revenue and between 11% and 19% of the primary deficit. Differently from the previous macro-oriented literature, we are able to track the effect of the policy by having access to monthly bank balance sheets and by verifying the bank mechanics behind the policy change. Specifically we observe that banks comply with the policy and start purchasing these new bonds as prescribed. This leads to an increase in safe asset holding, enhancing the banking system safety, and it also slows down year-on-year profit growth from 11% to 2%, in a context where banks' return on equity lies at 55%.

We believe our results are important and encourage additional research on the linkages between financial regulation and government revenue, especially on a variety of issues that are fundamental in several countries (i.e., optimality, welfare trade-offs, implementation, etc.). Indeed, we strongly believe there is generally insufficient empirical evidence on which policies low-income countries should pursue to boost financial systems and which trade-offs are encountered in their implementation.

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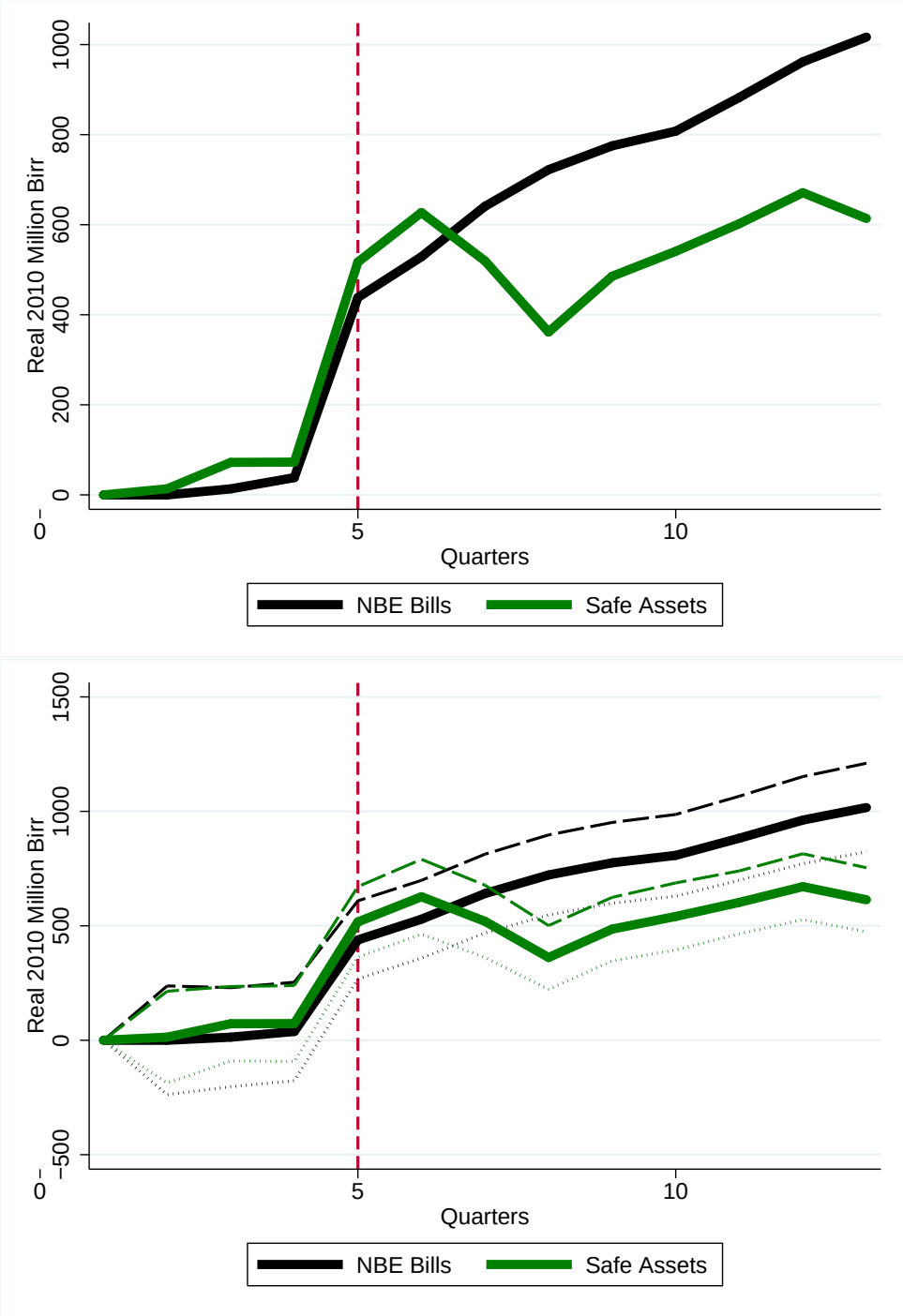
Table 1: Regulation and Compliance: Monthly Variation (Million Real Birr)

Variable	NBE Bills (Real Birr)				
	(1)	(2)	(3)	(4)	(5)
Lending × Policy	0.263	0.274	0.251	0.248	0.254
	(0.00752)	(0.00689)	(0.00868)	(0.00902)	(0.00976)
Bank FE		Yes	Yes	Yes	Yes
Year FE			Yes	Yes	
Month FE				Yes	
Non-Param. Month FE					Yes
Obs.	538	538	538	538	538
Number of banks	14	14	14	14	14
Adjusted R^2	0.889	0.950	0.959	0.959	0.959
Mean Dep. Var.	501.9	501.9	501.9	501.9	501.9
SD Dep. Var.	616.6	616.6	616.6	616.6	616.6

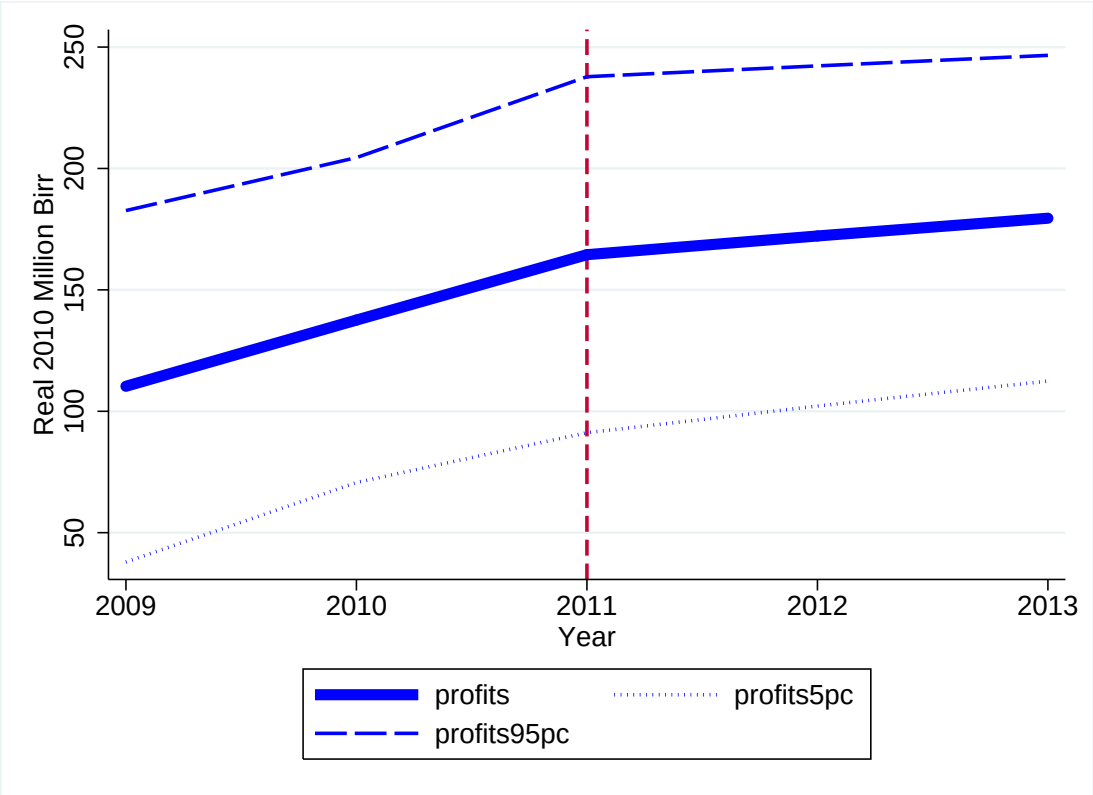
Note: This table reports OLS estimates. The unit of observation is bank level. Robust standard errors are in parentheses. NBE Bills is the amount of bills issued by the NBE in million birr, and is a continuous variable. Its mean and standard deviation are reported in the final two rows. The quantity of NBE Bills is regressed on "Lending × Policy", which is the interaction between Private Lending (in million birr) and a continuous variable, and the Policy dummy, taking unit value from April 2011 onward. In Tables A1 and A2, we also include the respective variables Lending and Policy as well as their interaction, without statistically detectable changes in the coefficient. The null hypothesis is that this coefficient is 0.27, as prescribed by the NBE directive, and we cannot reject this. In column (1) we exploit all variation. In column (2) we exploit only within-bank by introducing bank fixed effects. In columns (3) and (4) we also add year and month fixed effects, respectively. In column (5) we remove parametric month and year fixed effects and replace them with non-parametric effects for each month of each year (non-param. month FE). Appendix A reports an additional test of this null hypothesis including more indicators. All quantities are in millions of real birr, at their 2010 value. The adjusted R^2 of these regressions is also reported.

Figure 1: Regulation and Lending



Note: This figure reports the average evolution of monthly NBE bills (in black) and safe assets (in green) for all Ethiopian private banks between January 2010 and December 2013. The red vertical dashed line shows the introduction of the financial regulation policy, which forces banks to buy a negative yield government bond for every unit of private lending. The lower panel reports also the 95% confidence interval around these lines, using dashed and dotted lines. All quantities are in millions of real birr, at their 2010 value.

Figure 2: Regulation and Profitability



Note: This figure reports the evolution of yearly profits for all Ethiopian banks between 2009 and December 2013. The red vertical dashed line shows the introduction of the financial regulation policy, which forces banks to buy a negative yield government bond for every unit of private lending. The dashed and dotted lines indicate the 95% confidence intervals. All quantities are in millions of real birr, at their 2010 value.

Table 2: Regulation and Safe Assets: Quarterly Variation (Million Real Birr)

Variable	(1) NBE Bills (Real Birr)	(2) Safe Assets (Real Birr)
	Pre-Policy	
Quarter 2	0.1	13.56
	(120.9)	(102.1)
Quarter 3	13.44	72.27
	(110.1)	(82.79)
Quarter 4	38.41	72.81
	(109.4)	(84.50)
	Post-Policy	
Quarter 5	438.4	517.0
	(86.86)	(78.39)
Quarter 6	528.8	627.1
	(86.43)	(83.19)
Quarter 7	640.9	519.6
	(87.63)	(80.38)
Quarter 8	722.1	361.7
	(89.03)	(70.95)
Quarter 9	775.2	485.5
	(89.77)	(70.64)
Quarter 10	807.8	540.9
	(90.90)	(74.51)
Quarter 11	882.6	602.3
	(93.36)	(70.02)
Quarter 12	961.8	671.1
	(96.78)	(73.13)
Quarter 13	1,017	613.9
	(98.51)	(71.19)
Bank FE	Yes	Yes
Observations	538	538
Adjusted R^2	0.791	0.945
Mean Dep. Var.	501.9	1261
SD Dep. Var.	616.6	1062

Note: This table reports OLS estimates. The unit of observation is bank level and bank fixed effects are included. Robust standard errors are in parentheses. NBE Bills is the amount of bills issued by the NBE in million birr, and it is a continuous variable. Safe Assets aggregate at bank level the following assets: liquid cash, government bonds, NBE bills, bank-to-bank deposits, and voluntary reserves at the NBE. Their mean and standard deviation are reported in the final two rows. In columns (1) and (2), we regress the quantity of NBE bills and Safe assets, respectively, over a series of quarterly dummies, which fully describe the sample. These variables catch the average evolution of the accumulation of NBE bills and safe assets across the quarters. It is clear that as the policy is introduced in April 2011, which falls in Quarter 5, both NBE bills and safe assets start to markedly increase. As Figure 1 shows, this increase is close to being one-to-one. All quantities are in million of real birr, at their 2010 value. The adjusted R^2 of these regressions is also reported.

Table 3: Regulation and Profits: Yearly Variation (Million Real Birr)

Variable	Pre-Tax Bank Profits (Real Birr)	
	Pre-Policy	
Year 2009	110.3	(35.68)
Year 2010	137.6	(32.98)
Year 2011	164.5	(36.15)
	Post-Policy	
Year 2012	172.2	(34.53)
Year 2013	179.5	(33.08)
Bank FE	Yes	
Observations	52	
Adjusted R^2	0.904	
Mean Dep. Var.	126.2	
SD Dep. Var.	96.42	

Note: This table reports OLS estimates. The unit of observation is bank level and bank fixed effects are included. Robust standard errors are in parentheses. Profits are extracted from banks' individual annual profits and are reported in their before-tax expression in million birr; it is a continuous variable. The mean and standard deviation are reported in the final two rows. We regress over the available years to verify the average profit evolution in the banking industry, which (as expected) markedly declines after 2011. All quantities are in millions of real birr, at their 2010 value. The adjusted R^2 of these regressions is also reported.

Table 4: A Cost–Benefit Analysis of Diverting CBE Lending

Asset	Million Birr	Average Rate	Upper Bound	Lower Bound
	Panel A: Current Partial Asset Allocation			
(1) Government bonds	2.414,03	1.5%		
(2) Private sector lending	20.365,69	12%	7.5%	16.25%
(3) NBE Bills	0	3%		
(4) Partial revenue		2.480,09	1.563,63	3.345,63
	Panel B: Counterfactual Partial Asset Allocation			
(5) Government bonds	2.414,03	1.5%		
(6) Private sector lending	6.388,94	12%	7.5%	16.25%
(7) NBE Bills	13.976,75	3%		
(8) Partial revenue		1.222,18	934,67	1.493,71
	Panel C: Counterfactual Revenue			
(9) Revenue		−1.257,91	−628,96	−1.851,92

Note: This table reports the cost–benefit analysis of diverting private sector lending from the CBE to the purchase of NBE bills. For simplicity, in all panels, we only report a partial balance sheet, which includes only three assets: private sector lending, NBE bills, and Treasury bills. Panel A reports the current composition of the balance sheet, Panel B shows the balance sheet under the assumption that CBE needs to buy all NBE bills using private sector lending resources, and Panel C reports the counterfactual revenue of this exercise.

Chapter 4 - Manager Assignment and Project Returns: Evidence from the World Bank*

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1 Introduction

There are two salient features of development lending that make this different from commercial lending: a policy-reform objective and a financial subsidy. As Besley et al. (2015) and Deaton et al. (2006) discuss, the World Bank has been capable of generating a much stronger policy impact than its actual financial size and, in line with this view, Clemens and Kremer (2016) show how small the financial subsidy compares with the set of achieved reforms. Ultimately, the World Bank's leadership in development lending and agenda influence (Custer et al., 2015) comes from pro-actively engaging with local governments and bundling financial resources with technical assistance in its projects (Ravallion, 2016).

However, given its small and shrinking relative size in international capital markets, the *raison d'etre* of the World Bank resides in its informational functions (Rodrik, 1995) and knowledge generation (Chioda, De La Torre, and Maloney, 2013), which are operationalized through its technical assistance activities. These are organized and delivered by the project managers of the World Bank (Task-Team Leaders, or TTL, in internal World Bank jargo), that have a vital role in adding value to projects through their human capital and, in so doing, influencing development outcomes. They are responsible for delivering innovative ideas through technical assistance, setting up the loan specifics, and make projects happen by negotiating both with governments and the World Bank administration.

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The most relevant contribution in this respect is by Denizer, Kaufmann, and Kraay (2013), who pioneered the study of the macro and micro correlates of World Bank projects and were the first to provide a valuable contribution in assessing the role of World Bank managers in project success. One of their key conclusions encouraged the study of World Bank managers and, in general, the process of resource allocation within development lenders. In this paper, I advance their study and focus on whether, and to what extent, World Bank managers affect project success by introducing an alternative empirical tecniques (the value-added method), and I consider what determines the assignment of a high-performing manager to a specific country. This is relevant because there is little evidence that the organization and resource allocation of development lenders affects their performance; in contrast, there is a consensus that the recipient countries' own institutions and country-level differences affect results (Isham, Kaufmann, and Pritchett, 1997; Isham and Kaufmann, 1999; Casey et al., 2012; Olken et al., 2012). Project managers are the only resource I focus on: their ability and skills are probably the most important inputs available to, and used by, the World Bank, which can assign a manager to particular countries over certain periods through various means (promotions, lateral moves, incentives). On the receiving end, countries have an intrinsic interest in high-performing managers, both because they channel innovative ideas (Gavin and Rodrik, 1995) and, especially, because this makes it more likely that a loan will pass the World Bank's internal checks and will be approved. Conceptually, this paper links the literature on bureaucrats/political selection (Besley, 2005, 2006; Dal Bó, Dal Bó, and Snyder, 2009; Galasso and Nannicini, 2011) with the mounting evidence for the positive role of management (Bertrand and Schoar, 2003; Bloom and Van Reenen, 2007, 2010).

In order to measure the performance of World Bank managers and to understand what determines their assignment to a country, I regress an indicator of project success collected by the World Bank[1] on several covariates, including manager and country fixed effects (FE). These are then extracted to define the vector of manager effects (MEs) and of country effects (CEs), which are the core of this work and are methodologically borrowed from the teacher–pupil literature.[2] Inquiring into these effects gives rise to a surprising element: the variance of MEs is higher than that of CEs. This is surprising because while country performance is a given element of World Bank operations, and having high- and low-performing countries is an unchangeable issue, manager performance is ultimately a choice variable through hiring operations. An implication of this result states that the World Bank presents manager performance with a gap analogous to that existing between Somalia (among the lowest-performing countries) and Latvia (among the highest-performing countries). In order to verify the plausible interpretation of MEs and CEs as respective indices of performance in delivering successful projects, I note the relation between

[1]The key measure of project performance is available for most projects and for over more than 30 years – it is called the "project outcome rating". It represents a qualitative evaluation of the success of each project against its ex-ante stated objective. This is explained in greater detail in Section 3.

[2]In this work, I establish a parallel between "teachers affecting student outcome in certain schools" and "managers affecting projects in certain countries". As a result, I apply the teacher–pupil framework to the World Bank project setting.

predetermined manager curricula and MEs[3] and between countries' institutional variables and CEs.[4]

After the positive analysis to measure MEs and CEs, I move to a normative part and propose a reform to boost the World Bank's effectiveness in the spirit of Hanushek (2009): I reassign managers who are among the 10% worst-performing to non-project bureaucratic tasks and I replace them with average managers. Unlike some of the teacher literature, all economic indicators are available for this exercise and, therefore, I can directly estimate that such a reform leads to the creation of an additional 800 million US dollars (USD) of returns generated by the World Bank over the sample in analysis, in a confidence interval of [414, 1,189], corresponding to a 3.7% increase. Furthermore, using World Bank documentation, I evaluate the viability of this reform and conclude that this delivers net gains of 624 (426) million USD under a moderate (extreme) cost scenario, with a wide range included between 38 and 1,011 million USD.

With reference to the rule through which managers are assigned to countries, I inquire into this by correlating Manager with Country Effects. Conceptually this exercise parallels the worker-firm wage-determination literature, following the study of Abowd, Kramarz and Margolis (1999), and the management and organization field, in line with Bandiera et al (2015). A theoretical framework predicts that the World Bank's attitude to risk guides its assignment rule of managers to countries. I also allow some countries to put pressure on the World Bank to receive high-performing managers by sitting in its board, as the "value of the seat literature" suggests (e.g., Kuziemko and Werker, 2006; Kaja and Werker, 2010). This model gives rise to a proposition, which is brought to the data, and I verify that the empirical results are consistent with the World Bank behaving as a risk-averse planner, assigning high-performing managers to low-performing countries and with countries sitting on the World Bank board receiving higher-performing managers during their board terms[5]. Because this last point might be a result of reverse causality or third factors, exploit a unique feature of the World Bank's board elections to provide some plausibly exogenous source of board access, which reinforces my results.

Among the possible settings in development economics in which to extend the teacher–pupil work, the World Bank is ideal for at least three reasons. (1) The World Bank is one of the largest and oldest development institutions, with methodologically consistent databases dating back for more than 40 years. To exploit this feature, I join the World Bank Project Ratings database with information on project managers and other financial details and, in so doing, I

[3]As shown in a later section, the ME is correlated positively with managers holding a Master of Business Administration (MBA), completing a degree in their own country, and the number of their publications, and negatively with having work experience at the International Monetary Fund (IMF), experiencing a downgrading (i.e., a demotion from a higher hierarchical position to a lower position), and having graduated in natural sciences (i.e., medicine, mathematics, etc.). I also verify that MEs do not correlate with gender, experience, promotions, and spoken languages. These regressions and others can be found in Appendix C.

[4]As shown in a later section, the CE is correlated positively with "good" institutional measures such as parliamentary democracy, constraints on the executive, and an index of public infrastructure management, and negatively with ethnic fractionalization, slave trade, and legal origins.

[5]The presence of a negative assortative matching between managers and countries differs substantially from the results of the literature on the worker-firm wage determination, which finds evidence of positive assortative matching between high-wage workers and high-wage firms using analogous fixed-effects method (Abowd, Kramarz, and Margolis (1999), Andersson et al. (2012), Bagger, Sorensen, and Vejlin (2012)), Card, Heining and Kline (2013).

have access to 10,000 projects over a long span of time (from 1970 onward), comprising more than 15 sectors, 140 countries, and 2,000 managers. (2) World Bank project managers can be considered inputs to project success and in order to verify the plausibility of the manager effects correlations, I collect their corresponding curriculum vitae (CVs) and information using a variety of online sources (e.g., report biography, résumé, LinkedIn profile). (3) Last, but not least, the World Bank's institutional design and its governing board can be exploited to provide some plausibly exogenous source of board access, as shown at a later stage.

This paper contributes to various debates. First, it advances the debate on the economics and organization of not-for-profit and mission-oriented institutions (Besley and Ghatak, 2005; Besley, 2006; Ashraf, Bandiera, and Lee, 2014), especially for what concerns development lenders[6] and the presence of political equilibria in resource allocation (Grossman and Helpman, 1994; Coate and Morris, 1995; Krishna, 1998; Besley, 2006; Dreher, Sturm, and Vreeland, 2009). In this respect, my work joins a sizable body of literature on World Bank projects, which has already explored these data and provided useful insights into public policy and development lending (Chauvet, Collier, and Duponchel, 2010; Kilby, 2013, 2015; Presbitero, 2016). As previously mentioned, this paper advances the work of Denizer, Kaufmann, and Kraay (2013). They carefully explore macro- and micro-determinants of project success, establishing that within-country variation exceeds the between-country component, and they were the first to explore the role of project managers as the key to project success. In line with their initial contribution, two additional papers have carefully replicated and extended their work, including data also from the Asian Development Bank: Geli, Nobakht and Kraay (2014) and Bulman, Kolkma and Kraay (2016).

Furthermore, these results contribute to the extensive body of research using the teacher value-added framework (Hanushek, 1971; Gordon, Kane, and Staiger, 2006; Kane and Staiger, 2008; Chetty, Friedmand, and Rockoff, 2013) and applying it to a management perspective. Particularly, this work recalls the results on management and its performance-enhancing effects, and is in line with the findings of Bloom et al. (2013) in Indian firms, Bandiera, Barankay, and Rasul (2013) for team incentives, and Bennedsen, Pérez-González, and Wolfenzon (2012) for chief executive officers (CEOs). Last, but not least, this work adds to another body of literature

[6]Development lenders have been experiencing unprecedented growth and relevance in the aftermath of the Great Recession, both multilaterally with the founding of new players (AIIB in 2015, and BRICS Bank in 2012), and domestically as national development banks have stepped up in their asset growth. In the UK, the Growth Report elaborated at the London School of Economics (LSE; Aghion et al., 2013) proposes the creation of an Infrastructure Bank with all duties of a proper development bank to "to facilitate the provision of stable, long-term, predictable, mostly private sector finance for infrastructure". However, in emerging economies, development banks are on the rise: the China Development Bank (CDB), the Brazilian Development Bank (BNDES), and the Development Bank of Southern Africa (DBSA) have all been growing rates exceeding 20% in the last few years. For Brazil, refer to the article "A ripple begets a flood", *The Economist*, October 19, 2013, available at `http://www.economist.com/news/finance-and-economics/21588133-politically-inspired-surge-lending-weakening-state-owned-banks-latin`; for China, refer to the article "Massive Capital Injection to Chinese Banks is Credit Positive – Moody's", by M. North at Digital Finance Analytics Blog, August 24, 2015, available at `http://www.digitalfinanceanalytics.com/blog/massive-capital-injection-to-chinese-banks-is-credit-positive-moodys/`; for South Africa, refer to the DBSA's selection of publications, available at `http://www.dbsa.org/EN/About-Us/Publications/Pages/default.aspx`.

on the provision of public goods, the role of incentives, and selection of bureaucrats (Besley and Ghatak, 2003; Besley, 2005; Cruz and Keefer, 2013; Keefer, 2013; Rasul and Rogger, 2016).

In the following section, I present the measurement of the MEs and CEs, including an analysis of their main correlations and a few robustness checks. In Section 3, I present the core results of this paper on MEs and CEs. In Section 4, I study the assignment of managers to countries, illustrating with a theoretical model the problem faced by the World Bank as a planner and the instrumental variables (IVs) used for the analysis. In Section 5, I offer some concluding remarks.

2 Measurement and Data

2.1 Conceptual Framework

In this paper, I focus on deriving a fixed measure of managerial performance, and I interpret this as an input into project success. The idea of a ME is that there exists a set of individual-specific abilities and acquired skills that contribute to the success of each project, regardless of context-specific components. Because talents and skills are not observable, in the context of my analysis I extract an index of managerial performance by regressing an indicator of project success on manager fixed effects. I can then extract such effects and "rate" each manager based on how many "success points" they bring to a project. Statistically, I interpret this fixed effect as the conditional average performance of a manager, while conceptually the manager effect embodies a richer set of ability and acquired skills.

Under the assumption that such inputs are time-invariant, or that their time-changes are negligible, then the following framework, based on a general cumulative model of student achievement used in labor economics (Todd and Wolpin, 2003), can be used. I indicate with y_{imcst} the success of project i, led by manager m, in country c, of sector s, at year t, and model it through the following function

$$y_{imcst} = y_{imcst}[M_i(t), C_i(t), S_i(t), \Psi_i, \varepsilon_{imcst}].$$

Here, $M_i(t)$, $C_i(t)$, and $S_i(t)$ represent the entire histories of manager-, country-, and sector-specific inputs into project i[7], respectively, whereas Ψ_i embeds time-invariant characteristics of an individual project, and ε_{imcst} is an independent and identically distributed (i.i.d.) mean zero error.

While this model is difficult to estimate because of the high-dimensionality problem, it can be simplified and brought to a simpler expression through five assumptions.

Assumption 1 *The project success function is additive and separable in its arguments.*

[7] A history of country and sector specific inputs may represent a variety of cumulative knowledge that has built at country/sector level in generating a project (i.e. setting the appropriate quality controls, characterising the group of suppliers, structuring the auction procedures).

This leads to the following expression

$$\begin{aligned} y_{imcst} &= \alpha_1 M_{mt} + \alpha_2 M_{mt-1} + \ldots + \alpha_t M_{m1} + \beta_1 C_{ct} + \beta_2 C_{ct-1} + \ldots + \beta_t C_{c1} \\ &\quad + \gamma_1 S_{st} + \gamma_2 S_{st-1} + \ldots + \gamma_t S_{s1} + \delta \Psi_i + \varepsilon_{imcst}, \end{aligned}$$

where the success of project i depends not only on the contribution of manager m on i at time t, but also on its past history, and a similar story applies to country and sector inputs. This model could not be plausibly estimated unless information on past manager m inputs on project i were available, which leads to the following assumption.

Assumption 2 *Manager's inputs into the success of project i are constant over time and captured by a manager-specific effect ι_m.*

This assumption is fundamental and shuts down any possibility of managers compensating for poor country or sector inputs. Therefore, the project success model can now be rewritten as

$$\begin{aligned} y_{imcst} &= \alpha \iota_m + \beta_1 C_{ct} + \beta_2 C_{ct-1} + \ldots + \beta_t C_{c1} \\ &\quad + \gamma_1 S_{st} + \gamma_2 S_{st-1} + \ldots + \gamma_t S_{s1} + \delta \Psi_i + \varepsilon_{imcst}. \end{aligned}$$

However, this model relies on as yet unavailable information, and therefore, in order to reach a more compact expression, the following assumption is made.

Assumption 3 *Past inputs of country c and sector s into the project i decay at a geometric rate λ.*

Such simplification permits us to summarize the model as follows:

$$\begin{aligned} y_{imcst} &= \alpha \iota_m + \beta C_{ct} + \beta \lambda C_{ct-1} + \ldots + \beta \lambda^{t-1} C_{c1} \\ &\quad + \gamma_1 S_{st} + \gamma_2 S_{st-1} + \ldots + \gamma_t S_{s1} + \delta \Psi_i + \varepsilon_{imcst}. \end{aligned} \tag{1}$$

At this stage, I can define the success of a project j by manager n in country c in period $t-1$ as

$$\begin{aligned} y_{jncst-1} &= \alpha \iota_n + \beta C_{ct-1} + \beta \lambda C_{ct-2} + \ldots + \beta \lambda^{t-2} C_{c1} \\ &\quad + \gamma S_{st-1} + \gamma \lambda S_{st-2} + \ldots + \gamma \lambda^{t-2} S_{s1} + \delta \Psi_j + \varepsilon_{jncst-1}, \end{aligned}$$

and I describe the average project success in country c at time $t-1$ by summing over all N_{t-1} projects j:

$$\begin{aligned} \sum_j \frac{y_{jmcst-1}}{N_{t-1}} &= \sum_j \frac{\alpha}{N_{t-1}} \Big(\sum_h \iota_{nh} \Big) + \beta C_{ct-1} + \beta \lambda C_{ct-2} + \ldots + \beta \lambda^{t-2} C_{c1} \\ &\quad + \gamma S_{st-1} + \gamma \lambda S_{st-2} + \ldots + \gamma \lambda^{t-2} S_{s1} + \sum_j \frac{1}{N_{t-1}} (\delta \Psi_j + \varepsilon_{jmcst-1}). \end{aligned}$$

This expression can be simplified by recalling that the project-specific characteristics average a constant

$$\sum_j \frac{\delta \Psi_j}{N_{t-1}} = P,$$

while, relying on a weak law of large numbers, the previous period's error-term mean converges to the population mean of zero

$$\sum_j \frac{\varepsilon_{jmcst-1}}{N_{t-1}} = 0.$$

Finally, if the numbers of managers operating in country c at time $t-1$ are sufficiently large, described via N_{ht-1}, then we can normalize the average manager performance input to zero. Therefore, if the country experienced a sufficiently high number of managers, then by the weak law of large numbers

$$\sum_h \frac{\iota_{nh}}{N_{ht-1}} = 0.$$

Therefore, the previous period's average project success can be rewritten as

$$\begin{aligned} \overline{y}_{ct-1} &= \beta C_{ct-1} + \beta\lambda C_{ct-2} + \ldots + \beta\lambda^{t-2} C_{c1} \\ &\quad + \gamma S_{st-1} + \gamma\lambda S_{st-2} + \ldots + \gamma\lambda^{t-2} S_{s1} + \sum_j \frac{1}{N_{t-1}} (\delta \Psi_j + \varepsilon_{jmcst-1}). \end{aligned}$$

If we pre-multiply by λ and subtract this expression from equation (1), then

$$y_{imcst} = \lambda \overline{y}_{ct-1} + \alpha \iota_m + \beta C_{ct} + \gamma_1 S_{st} + \delta \Psi_i + P + \varepsilon_{imcst}.$$

Assumption 4 *Inputs by country c and sector s into the project i at time t can be expressed through three additive components (i.e., a country-specific component, a sector-specific component, and a time-varying component):*

$$\beta C_c + \gamma S_s = \beta \iota_c + \gamma \iota_s + \zeta \iota_t.$$

All of these assumptions lead to the following empirical model:

$$y_{imcst} = \lambda \overline{y}_{ct-1} + \alpha \iota_m + \beta \iota_c + \gamma \iota_s + \zeta \iota_t + \delta \Psi_{i0} + \varepsilon_{imcst}. \tag{2}$$

This compact model offers two central advantages: it can be estimated using the available data, and it presents an intuitive interpretation for most of its parameters. In line with Denizer, Kaufmann, and Kraay (2013), we are also estimating an equation in which the project outcome indicator is regressed over country and manager fixed effects. However, a key modelling difference is given by the inclusion of the lagged average project indicator, which removes elements of country-specific time-varying characteristics and therefore leads the estimated manager fixed-effects to be closer to the value-added interpretation.

On the contrary, the model presents also some disadvantages that need to be clearly high-

lighted: its central assumptions require the application of laws of large numbers that may not necessarily be realistic; the simultaneous presence of a lagged dependent variable and fixed effects may introduce some bias (which we are able to quantify later) and, finally, the elimination of the error terms through the law of large numbers is important to enable consistent estimation of the equation. Unfortunately many of these problems are common to the value-added literature and are subject to a usual disclaimer on the relation between the generality of the model and the specificity of the empirical setting. While some elements can be discussed subsequently (for example focus on few large countries that present longer panels or show that the measurement error at manager level does not systematically vary), some elements are to be taken as given (for example the short manager panel).

2.2 Data

Here, I describe the various datasets used for this analysis. First, I define the indicator of project success. This is measured by the "Project Outcome" indicator from the World Bank Project Rating database (from the "IEG historical project evaluations"), which is a collection of ratings assigned by World Bank evaluation teams to all financed projects since the early 1970s. This is the key database used in this analysis, and represents the starting point of this project. In order to characterize MEs and CEs, I have integrated each project in this database with the respective financial information and manager identity, by consulting all project archival documentation. In particular, because World Bank projects are long-lived and several managers can be in sequential charge of the project, I exploit the different available project documentation to extract information on the manager that presents the project to the World Bank board. This is typically the manager involved in the construction and preparation of the project and gives three advantages. First, this allows to consistently compare managers in the same position across different projects. Second, as highlighted by Kilby (2015), project preparation is among the most important determinants of project success and therefore these manager fixed effects are implicitly measuring this component. Third, the phases before project approval are those involving an intense technical analysis, discussion with governments, implementing agencies and World Bank internal units and these are the characteristics of a manager that this paper intends to highlight.

The project evaluations are organized by the corresponding World Bank regional office, which, in consultation with the project manager, appoints a team of evaluators. These work with other internal World Bank units and local authorities (i.e., borrower, implementing agency, etc.), all of whom provide comments and participate in shaping the evaluation. This results in a document, the "Implementation Completion Report", which assesses the project and provides the synthetic ratings in a six-scale measure ranging from highly satisfactory (6) to highly unsatisfactory (1), which are used in this analysis.[8] Project outcome is defined as "the extent to

[8]More information can be found in Denizer, Kaufmann, and Kraay (2013) or at the following web site `http://web.worldbank.org/WBSITE/EXTERNAL/PROJECTS/EXTPOLICIES/EXTOPMANUAL/0,,contentMDK:23071941~menuPK:4564187~pagePK:64709096~piPK:64709108~theSitePK:502184,00.html`.

which the operation's major relevant objectives were achieved", a synthetic measure of project success.[9]

The World Bank project evaluation procedure presents some merits and limits. On the positive side, given the standardized process of data evaluation, there emerges a clear set of indicators, which are inter-temporally comparable and present key project information. The importance of the evaluation is another useful element: as well as the evaluations organized by the regional office, the World Bank has its own "evaluation watchdog", the Independent Evaluation Group (IEG), which is responsible for monitoring the evaluations and supervising the procedures and responsibilities. The incentives of this internal authority are different from other parts of the World Bank, for example they do not report to the President (head of the administrative component), but directly to the World Bank Board, which is supposed to align the incentives toward a more neutral and objective system. However this process is far from perfect and there are a variety of elements that could weaken both the information content of such ratings and, in general, their use. In my econometric analysis I try to address a multitude of these. For example the indicators are measured toward a "stated" development objective, which could automatically adapt its measure to recipient characteristics: worse countries may be assigned more lenient development outcomes, which would potentially lead to automatically higher evaluations. With this respect, I address this by studying within-country variation and also showing that country effects are lower for lower-income countries, which counter this hypothesis. Another line of argument could claim that some managers may be to influence project outcomes, reducing the correlation with development outcomes. While this bias may be very hard to detect, in Appendix F I provide a few tests in this direction and show that my manager effect estimates are robust to the inclusion of a manager lag-project outcome variable, which may contain some of that manager time-varying bias.[10].

The following additional databases are also collected and used for various tasks.

1. *Individual Manager Characteristics.* This is a collection of manager characteristics, mostly based on individual CVs, which were collected using all available online resources (i.e., individual's web sites, LinkedIn profiles, book biographies, etc.). In this way, I can observe for 210 managers (among the 694 in analysis) a few predetermined characteristics (nationality, gender, experience, joining year, number of promotions/downgradings, advanced degrees, previous work experience, spoken languages and country of study, number of publications, discipline studied) and characteristics during their job at the World Bank (number of country changes, sector changes, total number of projects, average size of a project). This database allows me to verify the correlations between MEs and manager's

[9]According to the Independent Evaluation Group (IEG) Guidelines for Project Evaluation (see `http://ieg.worldbank.org/Data/HarmonizeEvalCriteria.pdf`), project outcome includes an assessment for the relevance of the project to the mission of the World Bank and the need of the country, the efficiency with which resources are used for the realization of the project, and the efficacy of the project in achieving the stated objectives.

[10]The ratings used in this analysis, ICR, are highly correlated with the IEG independent ratings and, in general, there are career concern arguments that would discourage the alteration of project successes. World Bank managers are not promoted on the direct basis of their project outcome, while engaging in a fight with IEG over how a project was assessed can be very expensive in terms of reputation. For example in Appendix C, I show that higher performing managers are not promoted more often.

individual characteristics.

2. *Countries Institutional Measures.* I group some of the most common variables, capturing countries' institutional features: parliamentary democracy and constraints on the executive (Besley and Persson, 2011), ethnic fractionalization (Easterly and Levine, 1997; Alesina et al., 2003), legal origins (Acemoglu et al., 2001), slave trade (Nunn, 2008), and a public infrastructure management (PIM) index (Dabla-Norris et al., 2012). Using this database, I can verify whether the CEs correlate with measures of institutions, which would be a natural predictor of the high performance in public good delivery.

3. *World Bank Board Composition.* Using all World Bank annual reports since 1980, I digitize the composition of the board for all years, and I verify the evolution of the electoral groups voting for a board seat (constituency groups in World Bank jargon), the number of countries belonging to each in each year, and how new countries are assigned to constituencies. This database is used in Section 4 to study the assignment of managers to countries.

2.3 Empirical Method

In terms of methodology, the most recent literature has proposed two alternatives: an empirical Bayes procedure, following Kane and Staiger (2008) and Chetty, Friedman, and Rockoff (2013), and a fixed effect estimation, in the spirit of Bertrand and Schoar (2003) and Gordon, Kane, and Staiger (2006). Because of the relatively short manager panel, I estimate the MEs using a fixed effect model[11] as described by equation (2).

The conceptual framework introduced in equation (2) can be brought to the data through the following regression:

$$y_{imcst} = \alpha + \iota_m + \iota_c + \iota_s + \iota_t + \beta_1 \bar{y}_{ct-1} + X_{1imcst}\beta_2 + X_{2ct}\beta_3 + \varepsilon_{imcst}. \tag{3}$$

Here, y_{imcst} is the project outcome variable indicating the success of project i, led by manager m, in country c, of sector s, at time t; ι_m, ι_c, ι_s, and ι_t are the fixed effects of manager, country, sector, and time, respectively, X_{1imcst} and X_{2ct} are project- and country-level controls, while $\bar{y}_{ct-1}$ is the average project success of country c in period $t-1$, and emerges from the project success model as a catch-all term of country time-varying heterogeneity.

[11] The fixed effect estimation is more tractable and has a clear interpretation. In addition to this, as I show in Appendix A, where I provide estimates using the empirical Bayes approach, there is high correlation (0.63–0.76) between the estimates of these two models when possible. Furthermore, as shown in the next section, by looking at the standard errors of the MEs, there is no systematic evidence of good or bad managers presenting higher variability. However employing this method has obvious drawbacks because I cannot remove the measurement error component from the MEs. The empirical Bayes approach has the advantage of disentangling the estimate of the ME, using a minimum variance unbiased estimator (MVUE), from the reliability of the information, expressed through a "shrinkage" parameter accounting for the signal-to-noise ratio. However, this procedure is extremely data-intensive and relies on observing a very large number of projects per manager, over countries and time. Unfortunately, my sample is not large enough to support this estimation and a value-added figure would be available for less than 15% of the total.

In order to be able to give a level interpretation to the fixed effects, I introduce four normalizations

$$\bar{\iota}_m = \sum_{k=1}^{N_m} \frac{\iota_{mk}}{N_m} = 0, \quad \bar{\iota}_c = \sum_{w=1}^{N_c} \frac{\iota_{cw}}{N_c} = 0, \quad \bar{\iota}_s = \sum_{j=1}^{N_s} \frac{\iota_{sj}}{N_s} = 0, \quad \bar{\iota}_t = \sum_{y=1}^{N_y} \frac{\iota_{ty}}{N_y} = 0.$$

These impose that the average manager, country, sector, and year fixed effects (i.e., $\bar{\iota}_m$, $\bar{\iota}_c$, $\bar{\iota}_s$, and $\bar{\iota}_t$) are equal to zero. Imposing these normalizations is useful because in this way the estimated fixed effects only provide a notion of how productive a manager is compared to the mean (a comparison across managers). These normalizations remove all elements of manager/country quantitative comparison: it would have little value to state that a manager contributes as much as a country to a project. Instead, I evaluate a manager by benchmarking against an average manager (normalized to zero for simplicity) and, analogously, I benchmark countries against a given zero-mean reference.

2.4 Sample Selection

At this stage, two fundamental features of the dataset need to be discussed. First, the identification of the MEs and CEs demands managers changing countries, countries changing managers, and multiple managers operating at any point in time. If this was indeed absent, the two effects would be perfectly collinear and their information indistinguishable. Secondly, because I am also interested in studying the allocation of managers to countries and the effect of a country sitting on the World Bank board on manager allocation, I exclude from my sample all projects during which a country sits on the board (out-of-sample estimation). In this way, I measure the MEs and CEs only for the years in which none of them operates through the board. Otherwise, this might lead mechanically to the discovery of a correlation between these two variables, if the presence of the board alters the technology of project returns.

For these two reasons, from the initial universe of 10,000 World Bank projects, I extract a sample such that each country and manager presents at least three projects, which offers support for the FE estimation: this restriction catches 3,385 projects from the initial 10,000, and from this I observe that a manager changes, on average, 3.19 countries and 2.11 sectors, while a country experiences 25.03 managers and 10.26 sectors. This is the main sample that I use for the analysis. However, in estimating MEs and CEs, I further restrict the sample to exclude projects performed while a country sits on the World Bank board.

This additional restriction leads me to exclude countries that always sit on the board and are more geo-politically relevant (i.e., China, India, Russia, Bangladesh, and Argentina) and this implies a further reduction, with the final sample shrinking to 2,240 projects.

Therefore I proceed in the following way.

1. I use the restricted sample of 2,240 projects to calculate each ME and CE.

2. I match each ME and CE to the corresponding manager and country in the sample of 3,385 projects, which also contains the same countries while sitting on the World Bank

board.

3. I aggregate the project-level data to country-year level, and investigate the manager-country allocation.

From the universe of 2,218 managers, I restrict my attention to 642 managers (28.94%). In Appendix F I show that this selected sample of managers does not differ from the remaining pool of managers along few important characteristics: 1. they do not conduct more successful projects on average; 2. their projects do not present higher economic rates of return (ERR); 3. the average interest rates on their projects are not statistically different from the other managers; 4. the countries in which their projects take place do not record statistically different average GDP per capita, which might indicate a particular selection procedure for such managers. As a result, though this is not a random sample, it seems to be representative along many dimensions that this analysis develops.

3 Results

3.1 Descriptive Results

Table 1 reports the results of the empirical model described in equation (3). It is useful to note that both the CEs and MEs are jointly statistically different from zero, while this is not the case for the sector fixed effects. For this reason, no policy experiment is conducted by varying the number of sectors. It is also interesting to note that the lag of mean project outcome of country c correlates negatively with the current project outcome, but is not significantly different from zero and is very close to zero in point estimate. This may seem surprising; however, in alternative regressions, this changes as CEs are suppressed. Therefore, the information content of this variable seems to be country-specific, time-invariant, and absorbed by the CEs.

An immediate concern from this estimation might be the relation between managers and countries: I might artificially find that a manager operating in a highly performing country receives a high fixed effect estimate. However, this is not the case – indeed, there are large within-country variations in MEs. Figure 1 provides graphical evidence, where the y-axis reports MEs, the x-axis shows the CEs, and each dot is a project. Therefore, the negative correlation and the substantial spreading out of managers for a country address possible concerns about whether the ME might be indistinguishable from the CE.

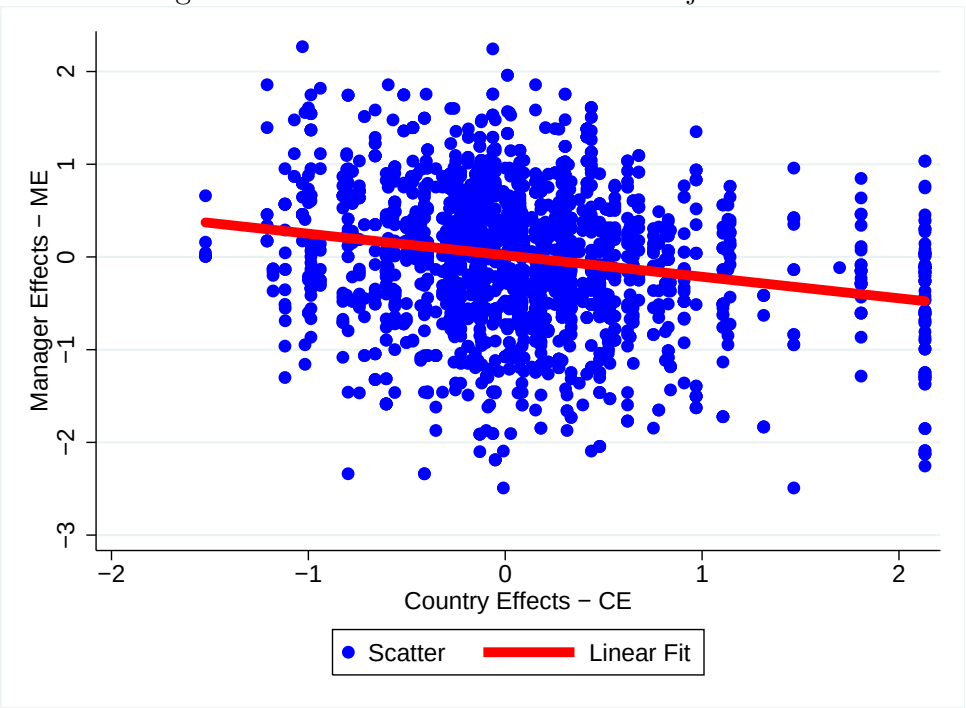
Another argument against my estimates could highlight the high standard deviation of MEs, 0.807, and my estimates might be considered to be a mere consequence of sampling error caused by the short manager panel. Though I cannot fully rule this out, I believe this to be a minor part of the story. In order to counter this, the upper panel of Table 2 reports the summary statistics of MEs for the whole sample and, in the lower panel, only for those managers with more than eight, six, or four projects. By comparing the standard deviations in these different samples (0.448, 0.468, and 0.571), it is clear that 0.807 might contain some noise due to managers with few projects. However, there seems also to be some relevant information.

Table 1: Estimating the MEs and CEs from World Bank Project Performance

Variables	Project outcome
Lag project outcome	−0.005 (0.042)
Constant	4.213*** (0.387)
FE country	Yes
Number of countries	125
FE sector	Yes
Number of sectors	15
FE manager	Yes
Number of managers	642
FE year	Yes
Number of years	31
Controls	Yes
Number of controls	24
Observations	2,240
p-value of F-test on CEs	0.000***
p-value of F-test on sector FE	0.655
p-value of F-test on manager FE	0.000***
p-value of F-test on controls	0.000***
R^2	0.462
Mean dependent variable	4.124
SD dependent variable	1.199

Note: This table reports OLS estimates. The unit of observation is project level and country, sector, manager, and year fixed effects are included. Standard errors are clustered at country level, with 125 units. Four normalizations are applied to this regression and impose that the mean of the country, sector, manager, and year FE are equal to zero, in order to simplify the level interpretation of the fixed effects. "Project Outcome" reports an ordinal rating assigned by the World Bank project manager to the outcome of the project, and is interpreted as a measure of project success. The variable ranges from 1 (highly unsatisfactory) to 6 (highly satisfactory) and the mean is reported in the row "Mean dependent variable". The rows beginning with "FE" indicate the presence of the fixed effect at country, sector, manager, and year level. The rows beginning with "Number of" report the number of available countries, sectors, managers, and years available in the database. The rows beginning with "p-value of F-test on" provide the results on a test of joint significance on all fixed effects at country, sector, and manager level, and also a test on controls. The included controls are: (1) at country level, population, exchange rate, real GDP per capita at constant prices; (2) at project level, the size of the project in constant USD, the interest rate on the loan, the month of approval, two lending type dummies, and 15 lending instrument dummies. The two mentioned lending types are, specifically, "Investment", for projects characterized by funding for governments to cover specific expenditures related to economic and social development projects, and "Development Policy operations", which are types of projects aimed at the provision of direct budget support to governments for policy and institutional reforms aimed at achieving a set of specific development results. There are 15 mentioned lending instruments, which characterize different financial packages in which the projects are designed and delivered to countries, for example the Adaptable Program Loan (APL), the Financial Intermediary Loan (FIL) or the Structural Adjustment Loan (SAL). All the country-level controls, the size of the project, and the interest rate are measured in continuous units, with approval month ranges in integers between 1 and 12, while the remaining are dummy variables.

Figure 1: Scatter of MEs and CEs: Project Level



Note: This figure shows a scatterplot, in which each dot is a project. It reports the associated MEs and CEs estimated in Table 1. The MEs and CEs are the fixed effects extracted from a regression of Project Outcome over country, sector, manager, and time FE, indicated in equation (2).

Finally, it could be claimed that two sources of bias might affect my estimates. The first is the Hurwicz–Nickell bias (Hurwicz, 1950; Nickell, 1981), provoked by the presence in model (1) of a lagged dependent variable combined with fixed effects. Two arguments can assist in addressing these claims. First, the Hurwicz–Nickell bias shrinks the fixed effects toward zero, analogously to an attenuation bias, and therefore pushes against the results that I present. Secondly, because the panel is relatively large both in $N = 125$ and in $T = 31$, it is known that such bias converges to a process $O(1/T)$, and is bound not to be larger than relatively few percentage points.

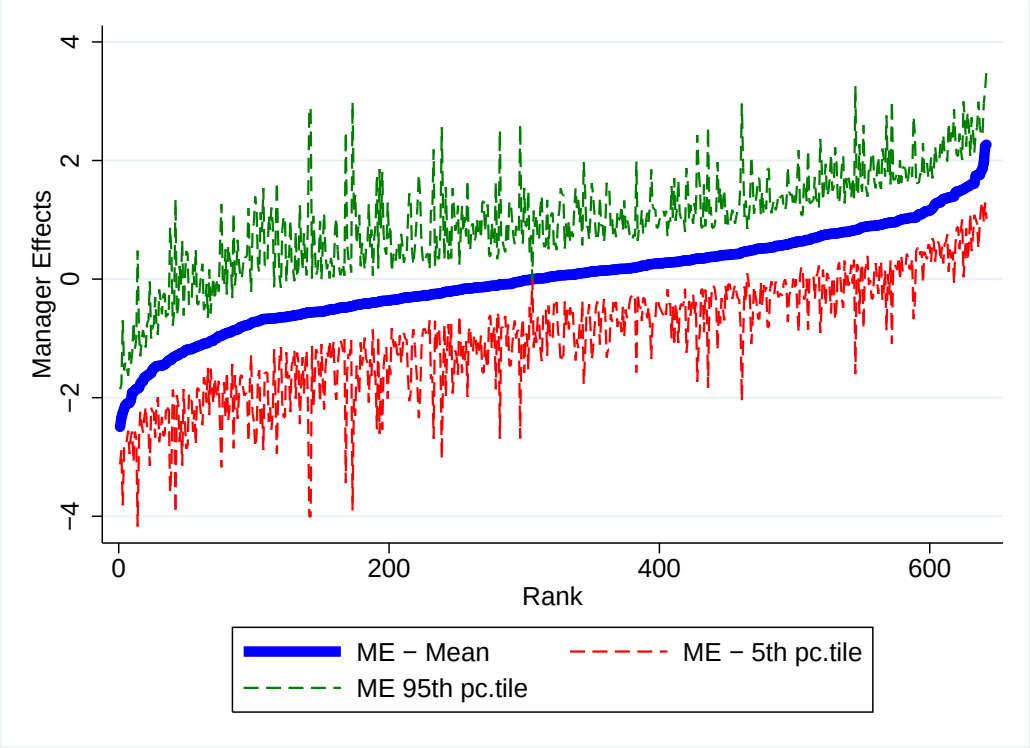
The second source of bias might be the result of the omission of a dynamic manager–country allocation rule. The conceptual framework in Section 2.1 implies that a manager–country allocation is a repetition of static problems, and therefore the fixed effect estimation catches this aspect if MEs are constant and CEs present an additive idiosyncratic component. However, a dynamic manager–country allocation rule might bias the fixed effects, as the error component would be correlated with the estimated MEs and CEs. In Appendix B, I explore the existence of a dynamic manager–country allocation rule exploring the time-series dimension of manager assignments, where I use country and manager performances at time $t - 1$ to predict their assignment at time t. I do not find evidence of dynamic matching.

Table 2: Summary Statistics on MEs and CEs

Variable	Obs.	Mean	Std Dev.	Median	Max	Min
(1) Manager Effects	642	0	0.807	0.062	2.268	−2.491
(2) Country Effects	125	0	0.651	−0.033	2.132	−1.522
(3) Project Outcome	2,240	4.124	1.199	5	1	6
Manager Level: Different Number of Projects						
(4) MEs: Number of Projects > 8	16	0.142	0.448	0.173	0.868	−1.063
(5) MEs: Number of Projects > 6	46	0.033	0.468	0.130	0.868	−1.063
(6) MEs: Number of Projects > 4	162	−0.006	0.571	0.030	1.394	−1.595

Note: This table reports the summary statistics of MEs estimated in Table 1, and the project outcome. MEs are the fixed effects extracted from a regression of Project Outcome presented in Table 1. In the upper panel, such summary statistics are presented for all MEs, CEs, and Project Outcome; the lower panel reports the summary statistics for all managers with more than eight, six, and four projects (rows (4), (5), and (6), respectively). Project Outcome reports an ordinal rating assigned by the World Bank project manager to the outcome of the project, and is interpreted as a measure of project success. The variable ranges from 1 (highly unsatisfactory) to 6 (highly satisfactory), and the mean is reported in the row "Mean dependent variable" of Table 1.

Figure 2: 95% Confidence Intervals of MEs



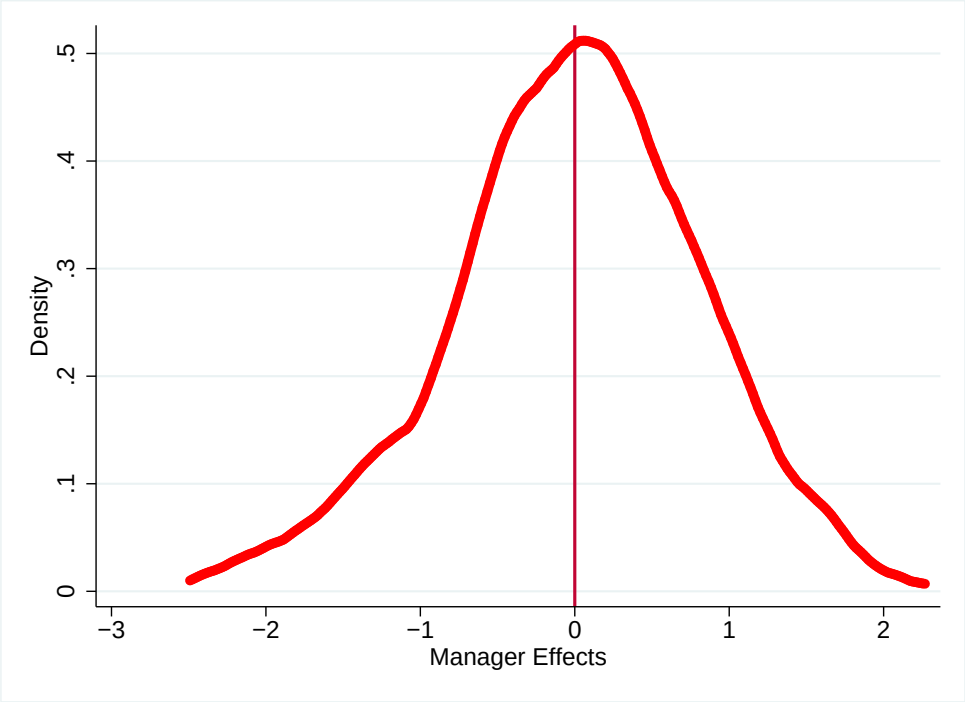
Note: This figure shows the full sample of MEs. The y-axis reports the point estimate of the MEs from Table 1, and the x-axis the rank of the manager. The thick blue line reports the point estimates. The upper green dashed line and the lower red dashed line represent the 95% confidence intervals of the point estimates.

3.2 A Validation of Manager and Country Effects

3.2.1 Inspecting Manager Effects

Here, I explore MEs and verify their correlation with project and individual characteristics. Before this exercise, it is interesting to provide a descriptive assessment of the MEs by studying

Figure 3: Density of MEs



Note: This figure shows the density of MEs. The y-axis reports the density of the distribution, and it is clearly noticeable that there is a thick left-tail of lower-performing managers.

Figure 2, which shows a blue line representing the MEs, with the upper and lower bounds of the estimates shown in green and red, respectively. Because of the short manager panel, manager standard errors are not small; however, both the bottom 10% and top 10% of MEs are statistically different from zero in their 5th or 95th percentiles. A graphical example of the existence of several "exceptionally bad managers" is evident from Figure 3, which reports the density of MEs and shows a noticeable left-tail of low-performing managers.

In Tables 3 and 4, I present some findings that support the interpretation of MEs consistent with the conceptual framework introduced in Section 2.1. Table 3 correlates the MEs to the manager's project characteristics: the length of a project in years (column 1), the number of countries changed over the career (column 2), the number of sectors (column 3), the number of managed projects (column 4), the average initial year in which a manager worked on projects (column 5), and the average financial size of projects (column 6). It is interesting to note that, with the exception of column (1), there is almost no action across the other margins; hence, this correlation states that more successful managers tend to complete projects more quickly than others. In this setting, given this relatively comparable set of projects, time to completion can be considered an alternative measure of success. Note that while Kilby (2015) finds that project preparation time is a positive determinant of project success (time spent on the project before its beginning), here I highlight that the actual project implementation time is positively correlated with the corresponding manager effect (the time elapsed from project beginning to end).

The next step is to relate MEs to individual characteristics, as presented in Section 2.2.

Table 3: MEs and Project-Level Correlations

Variables	(1) MEs	(2) MEs	(3) MEs	(4) MEs	(5) MEs	(6) MEs
Project Length	−0.0370**					
	(0.0163)					
Number of Countries		−0.0353				
		(0.0314)				
Number of Sectors			−0.0300			
			(0.0338)			
Number of Projects				−0.00954		
				(0.0138)		
Average Year					−0.00867	
					(0.00542)	
Average Project Size						0.000445
						(0.000368)
Observations	642	642	642	642	642	642
Mean Dep. Var.	0	0	0	0	0	0
Std Dev. Dep. Var.	0.807	0.807	0.807	0.807	0.807	0.807

Note: This table reports OLS estimates. The unit of observation is manager level and robust standard errors are in brackets. MEs is the vector of fixed effects (FE) extracted from a regression of Project Outcome over country, sector, manager, and time FE, including 24 controls and the mean lag project outcome, as presented in Table 1, column (1). Its mean and standard deviation are reported in the final two rows. Project Length measures the average number of years a project takes for each manager. Number of Countries is a continuous discreet variable, reporting the number of countries over which a manager has shifted during a career. Number of Sectors is a continuous discreet variable, reporting the number of sectors over which a manager has shifted during a career. Number of Projects is a continuous discreet variable, reporting the total number of projects executed by a manager during a career. Average Year is a continuous variable measuring the average year in which the projects of a manager took place. Average Loans is a continuous variable, reporting the average loan in constant USD held by a manager during an entire career.

Because not all the CVs of the 642 managers are publicly available, I am only able to analyze a subsample of 210 managers for whom I can observe all the variables reported in Table 4 and Appendix C. From this analysis, I find that MEs do not correlate with gender, number of promotions, year of joining the World Bank, years of experience, and number of spoken languages; all of these results are shown in Appendix C. In Table 4, I report only the characteristics that are significant. Thus, high MEs are for managers who do not hold a degree in natural sciences (i.e., medicine, mathematics, biology, chemistry), took an MBA, studied in their home countries (rather than abroad), did not work for the IMF, have a higher number of publications, and did not experience a downgrade in their career (from a hierarchically high position to a lower position).

The first four variables can be considered relatively pre-determined. For column (1), it might be possible that the World Bank is unable to attract the best candidates from natural sciences (especially medicine or mathematics) compared to other subjects, given that it offers a relatively uniform benefit package. Concerning the MBA variable, there might be other reasons for this, especially in terms of motivation. MBA students have access to higher salaries and fast

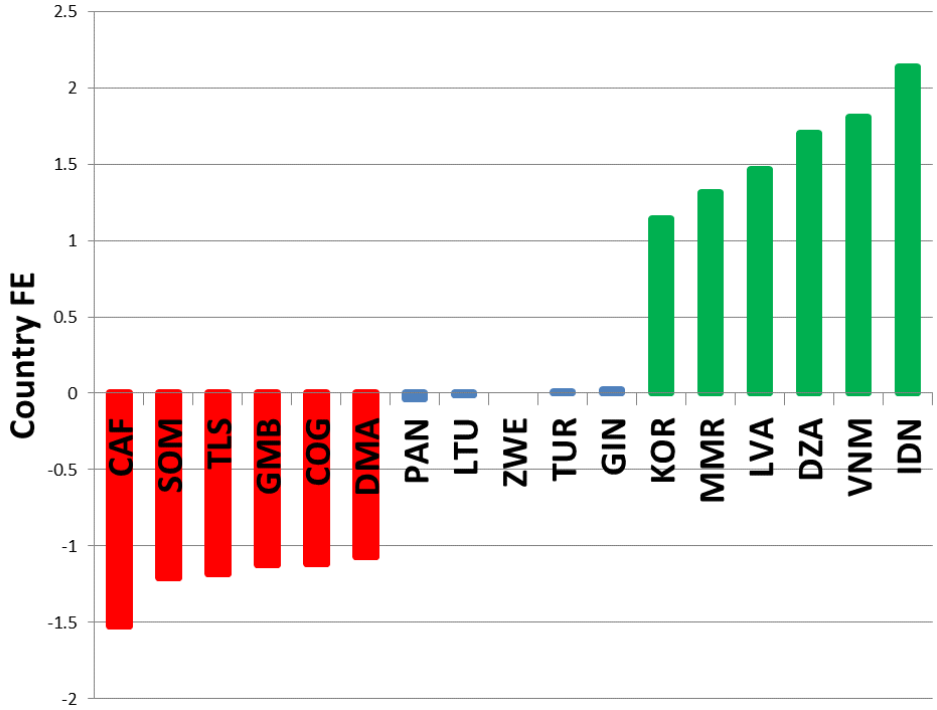
Table 4: MEs and Individual Correlations

Variables	(1) MEs	(2) MEs	(3) MEs	(4) MEs	(5) MEs	(6) MEs
Natural Sciences	−0.317*					
	(0.172)					
MBA		0.257*				
		(0.145)				
Studied in Home Country			0.160			
			(0.107)			
Former IMF				−0.316*		
				(0.197)		
Publications					0.00534*	
					(0.00327)	
Downgrade						−0.353***
						(0.132)
Observations	210	210	210	210	210	210
Mean Dep. Var.	0.03	0.03	0.03	0.03	0.03	0.03
Std Dev. Dep. Var.	0.745	0.745	0.745	0.745	0.745	0.745

Note: This table reports OLS estimates. The unit of observation is manager level and the standard errors in brackets are clustered at nationality level. MEs is the vector of fixed effects (FE) extracted from a regression of Project Outcome over country, sector, manager, and time FE, including 24 controls and the mean lag project outcome, as presented in Table 1, column (1). Its mean and standard deviation are reported in the final two rows. The right-hand side variables are collected from managers' CVs. Natural Sciences is a dummy taking unit value if a manager studied for a bachelor degree in medicine, mathematics, biology, and chemistry. MBA is a dummy taking unit value if a manager completed a Master in Business Administration. Studied in Home Country is a dummy variable taking unit value if the manager conducted some, or all, of her/his study in the home country. Former IMF takes unit value if a manager has past work experience with the International Monetary Fund. Publications is a count variable for the number of publications. Downgrade is a dummy variable, and takes unit value if a manager has been downgraded to a hierarchically lower position within their career.

careers, and hence those choosing to work for the World Bank might hold a particularly strong motivation for working in the development field. The third variable is particularly interesting and counter-intuitive, given that among the 210 managers, there are more than 70 represented nationalities, on average those achieving degrees in their own countries (rather than abroad) tend to present a higher fixed effect. One explanation for this result may be due to cultural assimilation: managers from particular regions (i.e., Africa) may be better equipped at working in those regions the stronger is their regional exposure. Indeed, in the last decade the World Bank has been re-directing its hiring toward local workers. However, this explanation is only one of possible co-existent ones. Finally, work experience at the IMF is associated with lower MEs. The remaining two variables are less pre-determined and might be a consequence of being successful: higher MEs are positively associated with the number of publications and negatively to a downgrade (being demoted from a hierarchically high position to a lower position).

Figure 4: Bar Chart of Selected CEs



Note: This figure shows a bar chart of a selected sample of the CE distribution. The y-axis reports the point estimate of the CE from Table 1, column (1). The x-axis gives the rank of the country. The rightmost countries, coloured green, are classified in the top five countries (i.e., Indonesia, Vietnam, Algeria, Latvia, Myanmar, and Korea). The middle countries, coloured blue, are the five countries around the mean (i.e., Panama, Lithuania, Zimbabwe, Turkey, and Guinea). The leftmost countries, coloured red, represent the bottom five countries (i.e., Central African Republic, Somalia, Timor-Leste, The Gambia, Republic of the Congo, and Dominica).

3.2.2 Inspecting Country Effects

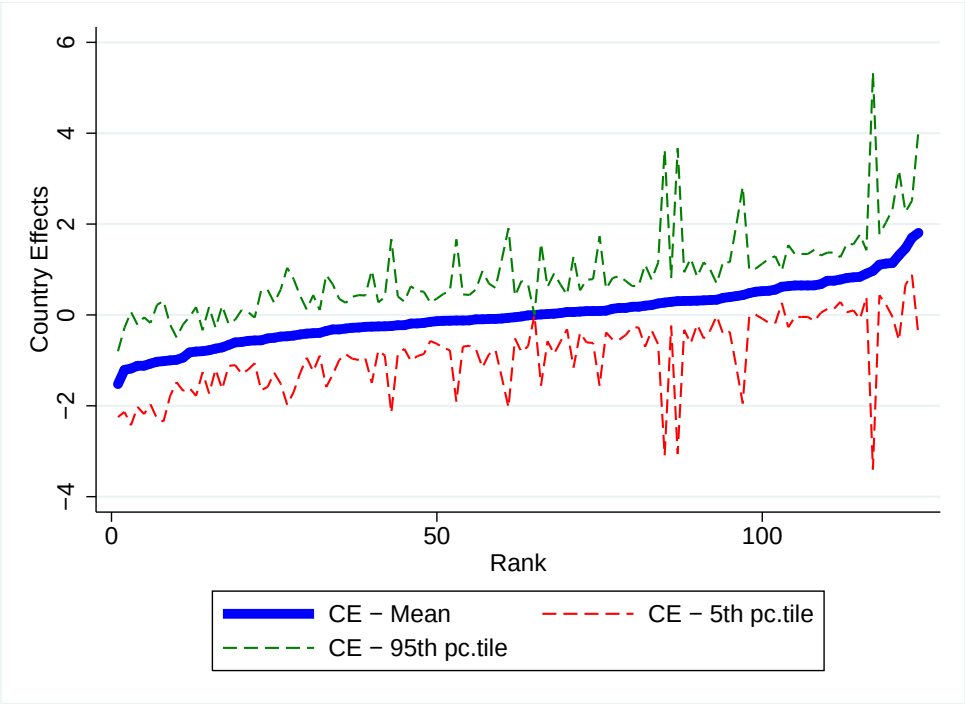
In this section, I inquire into the determinants of CEs and their main correlates at institutional level. The argument behind these robustness checks is that while MEs are thought to embed managerial performance, the interpretation of CEs is ex-ante less straightforward. In general, given the value-added interpretation, I can only describe a country with a higher CE as being higher-performing.

In this section, I attempt to go beyond this and provide some correlations showing that these fixed effects are highly correlated with a well-known series of institutional indicators. While this exercise does not lead to a conclusive interpretation of this effects, their information goes in the direction of a loose definition of a measure of public good provision.

First, it is interesting to provide a descriptive assessment of CEs. Figure 4 reports a bar chart, where I include the countries classified in the top five and the bottom five, and the five countries around the mean. Figure 5 reports the whole rankings including the 95% confidence interval around each estimate, and Figure 6 shows the density.

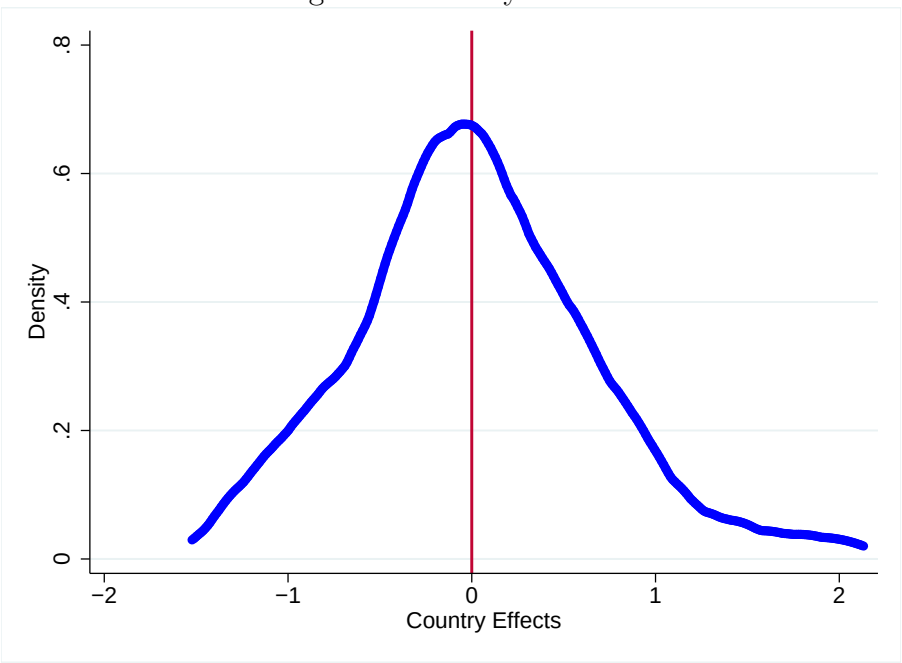
Figure 4 shows in green that some of the countries characterized by high CEs tend to be generally considered development successes (i.e., Indonesia, Vietnam, Latvia, and Korea). The bottom five countries, indicated in red, are countries with severe conflict problems, and still with large poverty gaps (i.e., Central African Republic, Somalia, Timor-Leste, The Gambia,

Figure 5: 95% Confidence Intervals of CEs



Note: This figure reports a bar chart of the 95% confidence intervals for CEs. The y-axis shows the point estimate of the CEs from Table 1, and the x-axis gives the rank of the country. The mean of the CEs is indicated with a thick blue line showing the point estimates; the upper green dashed line and the lower red dashed line represent the 95% confidence intervals of the point estimates. The two countries with a spike in their standard errors are Iran and Ivory Coast, which have a respective FE (and standard error of FE) of -0.310 (1.379) and 0.213 (1.792); their standard errors are twice as large as those of the other countries with the largest standard errors.

Figure 6: Density of CEs



Note: This figure shows the distribution of CEs. The y-axis describes the density of CEs, and it is noticeable that there is a fat right tail of high-performing countries.

Republic of the Congo, and Dominica).

From Figure 5, it is possible to verify that even if the confidence intervals are not small, the top 20% and bottom 20% (with few exceptions) can exclude a zero in their 5th or 95th percentile. Figure 6 shows the distribution of CEs, highlighting a substantial group of top performing countries, corresponding to a fat right-tail.

At this point, I inspect the long-run determinants of CEs. In Table 5, I regress the CE estimates over some of the most common institutional variables: a parliamentary democracy and high executive constraint dummy (Besley and Persson, 2011); slave trade (Nunn, 2008); ethnic fractionalization (Easterly and Levine, 1997; Alesina et al., 2003), legal origins (Acemoglu et al., 2001); the PIM index (Dabla-Norris et al., 2012). It is interesting to note that the CEs correlate as expected with all these variables: positively with parliamentary democracy in column (1), with high executive constraints in column (2), and with the PIM index in column (4), and negatively with slave trade in column (3), with ethnic fractionalization in column (4), and with legal origins in column (5). These results are in line with the expectation that countries with a high effect (productivity in public projects) have better institutions in the broad sense.

3.2.3 Robustness Checks

In this section I provide additional evidence on the estimated MEs, by proposing an exercise analogous to that in Kane and Staiger (2008). By extracting the manager fixed effects from equation (1), I define a "manager effects" vector, $ME_m = \widehat{\iota_m}$, which I now use as a regressor in my analysis. Recalling the original model, equation (1),

$$y_{imcst} = \alpha + \iota_m + \iota_c + \iota_s + \iota_t + \beta_1 \bar{y}_{ct-1} + X_{1imcst}\beta_2 + X_{2ct}\beta_3 + \varepsilon_{imcst}, \tag{4}$$

I define the ME vector $\widehat{\iota_m}$, which assigns to each manager a rating emerging from equation (4) and I define this as ME_m. In the following checks, I use this as a regressor, verifying how it changes at different levels of variation and introducing different controls. Therefore, the model employed for robustness checks follows

$$y_{imcst} = \theta ME_m + C_{imcst}\eta + u_{imcst}, \tag{5}$$

where the project success indicator, y_{imcst}, is run over the ME estimates, ME_m, and a vector of controls, C_{imcst}, which includes all the previous variables ($\overline{y}_{ct-1}, \iota_c, \iota_s, \iota_t, \Psi_{i0}$) as well as new variables. Under the hypothesis that MEs estimated in Table 1, column (1), are consistent, then my null hypothesis is $\theta = 1$ for a vector C_{imcst} and deviations of θ from the unit value can provide some insights on the direction of this bias.

Conceptually, this exercise has a clear interpretation. Suppose I am effectively measuring a manager's contribution to a project's success, then the introduction of additional controls or the exploitation of different sources of variation should not affect the main results. If the ME estimates measure the net effect of the manager on a project and not the result of other factors,

Table 5: CEs and Institutional Correlations

Variables	(1) CEs	(2) CEs	(3) CEs	(4) CEs	(5) CEs	(6) CEs
Parliamentary Democracy	0.0803					
	(0.181)					
High Executive Constraint		0.246*				
		(0.153)				
Slave Trade			−0.0285***			
			(0.0107)			
Ethnic Fractionization				−0.467*		
				(0.255)		
English Legal Origins					−0.605***	
					(0.162)	
French Legal Origins					−0.399**	
					(0.159)	
PIM Index						0.414***
						(0.103)
Observations	125	125	125	107	118	56
Mean Dep. Var.	0	0	0	0	0	0
Std Dev. Dep. Var.	0.651	0.651	0.651	0.651	0.651	0.651

Note: This table reports OLS estimates. The unit of observation is country level and robust standard errors are in brackets. CEs is the vector of fixed effects (FE) extracted from a regression of Project Outcome over country, sector, manager, and time FE, including 24 controls and the mean lag project outcome, as presented in Table 1, column (1). Its mean and standard deviation are reported in the final two rows. Parliamentary Democracy and High Executive Constraint are the average of two dummy variables, which respectively take unit value if a country is characterized as a parliamentary democracy in a given year or if it presents high constraints on the executive (taken from Besley and Persson, 2011). These dummies are averaged over the time period of this analysis (1980–2012). Ethnic Fractionalization is a continuous variable between zero and one, defined as one minus the Herfindahl index of ethnic group shares, as in Alesina et al. (2003). The legal origin variables (English and French) are dummies taking unit value if a country's legal and judicial system are based on one of the countries in brackets, as in Acemoglu et al. (2001); the omitted dummy is Socialist Legal Origins. Slave Trade is the measure of the intensity of the slave trade in a country, defined as the natural logarithm of slave exports normalized by a country's historic population (as in Nunn, 2012), interacted with a dummy taking unit value for the 49 countries for which this variable is available. Finally, the PIM Index reports the public infrastructure management index elaborated by Dabla-Norris et al. (2012).

then this should have a one-to-one correlation with project performance, whichever level of variation is studied.

Hence, in this section, I run equation (5) and test the null hypothesis $\theta = 1$ for the following cases.

1. Country–sector–year specifics. The MEs might be contaminated by an assignment that means that good managers are exposed to good countries/sectors in good years or good countries for good sectors. This selection would bias my estimates, because I would confound the ME with a dynamic matching effect. For this reason, I propose a set of regressions where I control for country × year, country × sector, and sector × year interactions, in different combinations.

2. Control for compensating effort at manager–country level. Suppose that a manager's ef-

fort in a project depends on the past project performance of a country (e.g., there might be arguments concerning political pressure or career concerns for which a manager would vary their contribution to a project as a best response to previous failing projects). For example, by exerting higher effort than usual after a failing project, a manager might increase their probability of receiving a promotion; or, after a failing project, a country might put pressure on the World Bank to provide a better manager. To address these claims, I control for an interaction between the ME and lag project outcome, because a standard omitted variable bias would arise. For this reason, I propose a set of regressions where I control for manager × lag project outcome and then introduce successive interactions (sector × project outcome, year × project outcome).

3. Control for country–manager and sector–manager pairwise FE. As a further robustness check, I run the standard regression, replacing CEs with country × manager and, in another form, with sector FE × ME. For the pairwise country–manager FE, I am verifying the within-country-manager cross-sector average contribution of a manager, while in the pairwise sector–manager FE, I verify the within-sector-manager cross-country variation.

The tests are applied to the following databases.

- The original sample comprises 3,385 projects executed in 127 countries, in 15 sectors, over 31 years, and with 697 managers. In this database, I can apply checks 1 and 2,but I do not have sufficient observations to apply check 3 for all countries. The standard errors are clustered at country level.

- For a large-country sample, I select the 10 largest recipients of World Bank operations, who register 743 of all projects overall. This allows me to apply tests 1, 2, and 3 through a country–manager pairwise FE, which is non-empty for 413 cases. The selected countries (and the number of their World Bank projects) are Brazil (123), Indonesia (121), Mexico (82), Pakistan (78), Colombia (74), Ghana (62), Morocco (60), Yemen (49), Philippines (47), and Tunisia (47). In this case, I do not cluster at country level, because of the low number of clusters, but rather at country–manager level. This has also the advantage of presenting more than twice the average number of managers per country, compared to the whole sample, which may make the estimates closer to the conceptual model.

In all three tests, I cannot reject the null hypothesis that $\theta = 1$. In some estimations, the point estimate lies below one (0.8) and in others above one (1.3), but the results are generally in line with the value-added literature. All the plausible biases that I presented in tests 1–3 are likely to be in place, although their magnitudes might be small enough not to invalidate the previous findings. All the tables can be found in Appendix F.

3.3 Evaluating a Reform

In this subsection, I explore the first-order gains that the World Bank would achieve by replacing the 10% worst-performing managers with average managers, and moving them to other

administrative tasks. Before discussing any reform that might affect project success, I need to present the benchmark against which any alternative can be compared. For this purpose, I use the results from Table 1 and construct the predicted outcome of a project, $\hat{y}_{imcst}$:

$$\hat{y}_{imcst} = \hat{\alpha} + \hat{\iota}_m + \hat{\iota}_c + \hat{\iota}_s + \hat{\iota}_t + \hat{\beta}_1 \bar{y}_{ct-1} + X_{1imcst}\hat{\beta}_2 + X_{2ct}\hat{\beta}_3. \tag{6}$$

This indicates the success of project i predicted in the presence of a manager m, in country c, in sector s, at time t, and by all project and country observables. In equation (6), the vector of MEs, $\hat{\iota}_m$, is key because it embeds the average manager contribution to a project. Therefore, a reform that affects the success of project i by replacing manager m with an alternative m^* results only in a change of the ME vector $\hat{\iota}_m$ only for the row with project i. In this specific case, the row i of the ME vector $\hat{\iota}_m$ is replaced with the FE of the new manager m^*.

In this way, I can construct alternative project success measures by introducing different manager rules. Here I focus only on one reform, CR, meant to increase the average rate of project success. This assigns all managers with an ME in the bottom 10% to a generic non-project bureaucratic task, and imposes in those projects the hiring of new managers with an average ME. Managers in the bottom 10% of the ME distribution add to the success rating of a project between -1.08 and -2.49 points: considering that the project outcome average is 4.1, then a manager in the bottom 10% reduces success by roughly 25%–60%.

The reform treatment group is composed only of those projects that are given a manager from the bottom 10%: in the counterfactual analysis, only these projects are passed on to an average manager, who presents a normalized ME of zero. Such a reform affects just 190 projects out of 2,240 (8.4%). All projects with a manager in the remaining part of the ME distribution are unaffected, and I am implicitly assuming that there are no general equilibrium effects of hiring new managers and moving old managers to other departments, and that there are no externalities in effort and motivation for existing managers. Therefore, the predicted outcome of a project in the presence of a reform, $\hat{y}^{CR}_{imcst}$, is given by

$$\hat{y}^{CR}_{imcst} = \hat{\alpha} + \hat{\iota}^{CR}_m + \hat{\iota}_c + \hat{\iota}_s + \hat{\iota}_t + \hat{\beta}_1 \bar{y}_{ct-1} + X_{1imcst}\hat{\beta}_2 + X_{2ct}\hat{\beta}_3 \tag{7}$$

where equation (7) differs from equation (6) only for the vector $\hat{\iota}^{CR}_m$, which equals its estimated counterpart $\hat{\iota}_m$. The sole exception is that I am substituting the lowest 10% values (between the 10th percentile, -1.08, and the lower end of the support, -2.49) with a zero, the average. Using this method, the gains in project outcome for those projects i under the reform, CR, are

$$\Delta\hat{y}^{CR}_{imcst} = \hat{y}^{CR}_{imcst} - \hat{y}_{imcst}. \tag{8}$$

Table 6 provides the summary statistics of such a gain for the treated projects only, keeping in mind that the untreated projects record no change. Rows (1) and (2) present the summary statistics of these projects before and after the reform, respectively, and row (3) presents the difference between the two (i.e., the gain). The most important result is given by the substantial extent of the increase: on average, a project increases its success score by 1.476 points out of a

pre-reform mean of 3.073, which is almost a 50% boost. Because the predicted project returns may exceed the maximum rating of 6, in Appendix C we report an alternative table in which the results of Table 6 are correspondingly adjusted: the key finding is slightly lower (1.321 versus 1.476), but still very large.

Table 6: Summary Statistics of a Reform (CR)

Variables	Obs.	Mean	Std Dev.	Median	Min	Max
(1) Project Outcome: Predicted	190	3.073	1.582	2.960	−0.249	6.727
(2) Project Outcome: CR	190	4.550	1.584	4.416	1.305	8.161
(3) Project Outcome Gain: CR	190	1.476	0.340	1.407	1.075	2.491

Note: This table reports the summary statistics of gains in the outcome of those projects involved in the reform, CR. The Project Outcome Gain is defined as the difference between the new counterfactual project outcome minus the project outcome predicted by model (3). The reform, CR, simulates what would happen if the World Bank were to reassign the 10% worst-performing managers to non-project tasks and were to replace them with average managers. A description of the experiment can be found in the text.

3.3.1 Calculating the Economic Gains of a Reform

Here, I propose a calculation for the economic gains of the reform. Until this point, I have focused my attention on the project rating measure, y_{imcst}, as an ordinal measure of success, and have estimated the extent to which this variable would vary with the reassignment of managers/countries. Now, I go a step further and exploit information from the economic rate of return (ERR) of the project. These two variables are conceptually and intimately related. Table 7 highlights the fact that each additional point in the project outcome rating, which indicates a more successful project, does translate to roughly four extra points of ERR. Therefore, once the ERR definition is taken seriously, I can evaluate the economic gains of the two reforms and provide some million-dollar measure estimates. As Duvigneau and Prasad (1984) have formalized in a World Bank technical publication (for more details, also refer to Squire and Van der Tak, 1975), the ERR measures the internal return of a project by accounting for the costs incurred and the gains generated by its realization, and adjusting market prices to reflect the effects of the project.[12] This analysis relies on considering World Bank projects as a single-period investment, delivering a certain return (expressed through the ERR) and at a given cost

[12]Specifically, Duvigneau and Prasad (1984) indicate that the ERR "treats import duties, sales taxes, profit taxes, and other government levies (or subsidies) as internal transfers within the country and disregards them, since they do not affect the overall wealth of that economy. It also uses 'shadow prices' (see para 6.03 below) instead of domestic input and output prices, in case they do not adequately reflect the opportunity costs to the economy. For traded goods, shadow prices (or economic prices) are international (or world) prices at the border of the country (border prices) [...]. For non-traded goods (for example, land), the economic cost is defined as the value of net output foregone (when using that good in the best alternative use) as a result of using that good in the project. Use of shadow prices enables one to see beyond the effects of tariffs, exchange rates, interest rates, and wage rates, as well as administered prices, subsidies, and surcharges that distort a product's true scarcity value. It enables one to measure an investment's efficiency of using the resources of an economy, priced at border prices." The ERR differs from the financial rate of return (FRR) because this supposedly reflects the general equilibrium effects of a project. For this reason, the ERR of a project can largely exceed its FRR, if it alleviates some binding development constraints.

Table 7: ERR and Project Outcome

Variables	Ex-post ERR		
	(1)	(2)	(3)
Project Outcome	4.803***	4.776***	3.706***
	(0.841)	(0.846)	(0.913)
Country FE	Yes	Yes	Yes
Sector FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Manager FE		Yes	Yes
Controls			Yes
Mean Dep. Var.	23.6	23.6	23.6
Observations	840	840	840
Adjusted R^2	0.361	0.369	0.873

Note: This table reports OLS estimates. The unit of observation is project level and country, sector, manager, and year fixed effects are included. Standard errors are clustered at country level. The ERR at the end of a project (i.e., ex-post ERR) is a continuous variable, defined in a World Bank technical paper by Duvigneau and Prasad (1984) as the economic merit of a project by accounting for the gains and costs caused by the project. Its mean is reported in the "Mean Dep. Var." row. Columns (1), (2), and (3) report the results of a regression of the ERR over country, sector, manager, and year fixed effects, including all the 24 previously used controls. The included controls are: at country level, the population, exchange rate, GDP per capita, the GDP share of consumption, government spending and investment, and population density; at project level, the size of the project in constant USD, the interest rate on the loan, the month of approval, two lending type dummies, and 15 lending instrument dummies. The two mentioned lending types are, specifically, "Investment", for projects characterized by funding for governments to cover specific expenditures related to economic and social development projects, and "Development Policy operations", which are types of projects aimed at the provision of direct budget support to governments for policy and institutional reforms aimed at achieving a set of specific development results. There are 15 mentioned lending instruments, which characterize different financial packages in which the projects are designed and delivered to countries (e.g., APL, FIL, and SAL).

(the interest rate). A richer analysis would take into account the multi-period component of projects, and the corresponding compounding of returns. While this is a topic which would require additional discussion, at this stage I am focusing on the one-period assumption as in (Duvigneau and Prasad (1984), Squire and Van der Tak (1975)), acknowledging the importance of this extension, which would however only lead to larger estimates for the returns of such a reform.

Using the results presented in Table 6, I can calculate how the reform affects the generation of the ERR. Recalling that the replacement of managers (i.e., the reform, CR) resulted in an increase in the project success rating for each project (on average, 1.476 points), then the average increase in ERR for the 190 projects j treated by this core reform is

$$\triangle \overline{ERR}^{CRj} = \triangle \overline{ERR} \times \triangle \overline{Success}^{CR}.$$

By exploiting the results of Table 7, I can construct this counterfactual ERR gain as the product of the marginal effect of an increase in project success on ERR (3.706 from column (3) of Table 7), $\triangle \overline{ERR}$, times the average gain in project success generated by the reform, $\triangle Success^{Tj}$.

This leads to the following:

$$\triangle\overline{ERR}^{CR} = 3.706 \times 1.476 = 5.470 \in [2.829, 8.111].$$

Therefore, the reform increases the average ERR of treated projects by 5.470 points, with a 95% confidence interval shown in brackets (which accounts for the standard errors of the impact of project outcome on ERR). Recalling that the average ERR of a project is 23.6 percentage points, this implies a 23% increase.

I can also define the economic gains of project i led by manager m in country c in sector s at time t, $Gain_{imcst}$,

$$Gain_{imcst} = (ERR_{imcst} - Int.Rate_{imcst}) \times Amount_{imcst},$$

as the product of its economic rate of return, ERR_{imcst}, minus the interest rate of the project, $Int.Rate_{imcst}$, times the constant million-dollar amount of the project, $Amount_{imcst}$. It is important to highlight that because in the definition of ERR given by Duvigneau and Prasad "interest charges are excluded", I subtract these from the definition of gains.

Unfortunately, ERRs are only available for 840 of the projects in my sample (37.5%), and for this reason I cannot extend the previous calculation without further work. Under the assumption that the projects with an available ERR are a representative sample, I can construct a predicted ex-post ERR using the coefficients of Table 7, column (3). Hence, I have an empirical analogue available for all projects, $\widehat{ERR}_{imcst}$.

Because all the required information is available, I can calculate the overall economic gains of the reform CR by summing the economic gains of each individual project

$$Gain^{CR} = \sum_i (\widehat{ERR}^{T}_{imcst} - Int.Rate_{imcst}) \times Amount_{imcst}, \tag{9}$$

where the ERR of project i varies for those projects that are treated by the reform CR. This calculation gives rise to the figures reported in Table 8. Row (1) reports the aggregate economic gains by using the observed interest rates, project amounts, and predicted ERRs, while Row (2) shows the aggregate gains once the 10% worst-performing managers are replaced with their means. The "Total Gain" column indicates a figure in billion constant dollars of the economic returns generated by World Bank projects in my sample, with its 95% confidence interval presented in the next column. In order to have some quantitative interpretation of these reforms, the column "% Increase" shows the percentage increase in the total gains by introducing the reform (i.e., 3.7%). As a reference, I also present the column "Total Spending", which shows an aggregate figure of the whole resource spent by the World Bank. Comparing the gains with the spending, we can define the ratio as how many dollars the World Bank produces by lending one dollar to a country. In this case, we can see from my sample that the World Bank produces 12.8 constant dollars of net returns for every 100 dollars lent to a

country, which increases to 13.3 after the reform[13].

Table 8: Economic Gains of a Reform

Variables	Projects	Total Gain	95% Interval	% Increase	Total Spending
(1) Economic Gains: Predicted	2,240	21.895			170.216
(2) Economic Gains: Reform	2,240	22.697	[22.309, 23.084]	3.7%	170.216

Note: This table reports the economic gains generated by the World Bank, using equations (7) and (9). Row (1) reports the observed economic gains, while row (2) reports the counterfactual gains by respectively replacing the 10% worst-performing managers and countries with their respective means. The column "Total Gain" (expressed in billions of constant USD) reports the aggregate sum of economic gains in all World Bank projects. The column "95% Interval" reports the 95% confidence interval of the Total Gain, where instead of multiplying the project outcome gain by the point estimate of Table 7, column (3), I use the 95% confidence interval of this estimate. The column "% Increase" reports the percentage increase in economic gains by applying the reform of manager reassignment. "Total Spending" accounts for the aggregate World Bank spending on all projects, in billions of constant USD.

3.3.2 Cost–Benefit Analysis

Here, I report a cost–benefit analysis of this intervention, comparing the gains of the core reform with its cost. While the gains have already been explained, the costs comprise two components: the hiring and search costs for 66 additional average managers. From the 2013 World Bank Annual Remuneration Disclosure Note,[14] it can be seen that a manager costs roughly 300,000 USD per fiscal year, composed of a tax-free average salary of 188,958 USD, and other benefits (e.g., health insurance, termination benefits, family allowances) amounting to 108,027 USD.

In order to provide a lower-bound (and upper-bound, in brackets) estimate of hiring costs, I consider for all managers a payment period of 8 (16) years, which means that they are hired at the age of 54 (46) and paid until the mandatory World Bank retirement age of 62. This leads to a lower-bound (upper-bound) scenario of hiring costs for all 66 managers totaling 178 (376) million USD.

Regarding the search costs, I assume that in the lower-bound (upper-bound) case the search for an average manager costs one (three) full yearly manager salary. This means that 19.8 (59.4) million USD are dedicated only to search costs. In Table 9, I report a synthetic summary of the overall cost–benefit analysis of this reform, considering the 95% confidence interval bounds

[13]One possible concern might be that by using the predicted ERR for projects without a published rate, I might be treating analogously very different projects. Indeed, looking at Figure E1 in Appendix E, it is noticeable that most of the projects with unpublished figures tend to record negative rates of return. For this reason, I perform the same exercise in Table E1, under two alternative assumptions for projects with a missing ERR. In the upper panel, I replace all projects with a negative ERR with a zero; in the lower panel, I replace all negative figures with the mean ERR. These produce the obvious effect of inflating the figure of the total gains produced by the World Bank by three and five times, respectively. Correspondingly, this reduces the percentage extent of the reform, from a 4% increase in Table 8 to an increase between 3% and 0.2% in Appendix E. Clearly, the absolute estimate of the increase in the gains generated by the World Bank does not change, whichever accounting device is used (i.e., 0.8 billion USD).

[14]Refer to the following World Bank document, `http://siteresources.worldbank.org/EXTANNREP2013/Resources/9304887-1377201212378/9305896-1377544753431/Remuneration.pdf`.

(in the upper- and lower-bound columns). On average, this reform delivers 624 million USD under a moderate scenario, and 426 under an extreme scenario; under no circumstances is the reform not viable, and the gains are always strictly positive and included in a range between 38 and 1,011 million constant USD.

Table 9: A Cost–Benefit Analysis of a Reform

Variables	Projects	Average	Upper Bound	Lower Bound
Panel A: Lower-Bound Scenario of Hiring Cost				
(1) Gains of the Reform	2,240	802	1189	414
(2) Costs of the Reform	2,240	178	178	178
(3) Total		624	1,011	236
Panel B: Upper-Bound Scenario of Hiring Cost				
(4) Gains of the Reform	2,240	802	1189	414
(5) Costs of the Reform	2,240	376	376	376
(6) Total		426	813	38

Note: This table reports the cost–benefit analysis gains of the reform affecting the World Bank. Panels A and B report different scenarios on the costs of the reform, under moderate and extreme scenarios, respectively. Rows (1) and (4) report the gains of the reform, as calculated in the previous sections, rows (2) and (5) report the costs of the reform including both the hiring and search costs, while rows (3) and (6) report the sum of these two. The Average column expresses the average costs and benefits of the reform. In the Upper Bound and Lower Bound columns, I introduce the 95% confidence interval bound estimates for the gains. All figures are expressed in constant international 2005 million USD.

3.3.3 The Results of a Reform

In this section I take stock of the results of the reform in analysis. The objective of this exercise is to improve the results achieved by the World Bank by assigning the 10% worst-performing managers to non-project bureaucratic tasks, and replacing them with average managers. Because several economic indicators are available at project level (the USD amount of each project, its interest rate, the ERR, etc.), I can account for the benefits and the costs of such reform.

It is important to notice that given the available sample, such reform affects relatively few under-performing managers and projects, respectively only 66 and 190. I find the following results.

First, projects in which an under-performing manager is replaced by an average manager experience on average a 50% increase in their success rating (as measured by the project outcome variable, from 1.476 points out of a pre-reform mean of 3.073). Secondly, such increase in project performance maps into an average increase in the economic rate of return of treated projects by 23% (the reform leads to 5.470 average points added to treated projects, compared to a mean of 23.6 points). Thirdly, higher returns on projects translate in the creation of an additional 800 million USD of returns generated by the World Bank, corresponding to a 3.7% increase. Finally, by consulting World Bank documentation, I am able to provide plausible cost scenarios to evaluate the viability of the reform, which would deliver net gains of 624 (426) million USD under a moderate (extreme) cost scenario, with the range included between 38 and 1,011 million

USD[15].

4 Manager and Country Assignment

4.1 Theoretical Framework

In this section I study the assignment of managers to countries, and I focus on the role of institutional risk aversion. My approach captures a first-order feature of the manager allocation problem and ample official documentation and articles point to this feature being central in the institutional culture at the World Bank[16].

4.1.1 Environment

A planner (i.e., the World Bank) has access to N managers and decides their assignment to N countries. All of these are endowed with a given measure of performance in generating project returns, which is constant, fixed per individual and does not respond to the performance of the assigned country. This is conceptually equivalent to the ME described in the previous sections, and this is perfectly observable to the planner. Manager performance is described by m_i, and ordered so that the Nth manager presents a higher performance than the $N-1$th manager, the $N-1$th presents a higher performance than the $N-2$th, and so on. Hence, $m_N > m_{N-1} > \ldots > m_1$. Analogously, country performances are described by c_j, are fixed and unchangeable and the same normalization follows $c_N > c_{N-1} > \ldots > c_1$. However, the planner observes in every period a noisy performance for countries, and therefore $c_{jt} = \widetilde{c}_j + \varepsilon_{jt}$ and $\varepsilon_{jt} \sim \text{i.i.d.}(0, \sigma^2)$. I simplify the dynamic allocation as a repetition of static problems, and therefore in the remaining sections I omit the subscript t. In addition to this, I normalize both performances so that the average manager and country performance equals zero:

$$\overline{m} = \sum_i \frac{m_i}{N} = 0 \qquad \text{and} \qquad \overline{c} = \sum_j \frac{c_j}{N} = 0.$$

This assumption simplifies the modeling and allows an interpretation of MEs and CEs in the following sections.

[15]Given that my sample spans across several countries and years, these results are to be considered a counterfactual aggregated lump-sum generation. An appropriate interpretation of these results could be the following: "the World Bank would have generated additional 624 million USD between 1980 and 2010 by replacing the bottom 10% under-performing managers with average managers, caeteris paribus".

[16]For example, the World Development Report 2014 (World Bank, 2014) specifically addresses the issue. In fact, "The World Bank Group is currently undergoing a transformation, which calls for shifting the institutional culture regarding risk from one of extreme risk aversion to one of informed risk taking". This is indeed consistent with anecdotal evidence on the internal bureaucratic practices that encourage risk aversion from an institutional perspective: "as the (project approval) process has evolved over time, it has accrued layers of bureaucracy that require staff to 'bullet-proof' their projects before these even make it to the approval stage" (Stephens, 2014). However, this is not the only possible explanation in line with the empirical results. Other explanations are admissible and possibly co-existent. For example, the results could be rationalized through a purely technological story: a submodularity in the project return production function with respect to MEs and CEs.

There are two stages in this game. First, the planner assigns manager i to country j, indicated as $m_{i,j}$. Secondly, the project is successful with probability π, and hence they generate returns in a project with a linear technology $y_{i,j} = m_{i,j} + c_j$; otherwise, the project fails, and with probability $1 - \pi$ such returns are zero.

Planner preferences are described by a quadratic Bernoulli with risk parameter β over total returns, $Y = \sum_j y_{i,j}$, $U(Y) = Y - \beta Y^2$. Because manager and country performances are normalized to zero, this expression simplifies only to the variance component of project returns; in Appendix A, I show that this is described by $V(Y) = (1/N) \sum_j \pi y_j^2$. Therefore, the optimal allocation of manager i to country j emerges from

$$\max_{m_i} -\beta \, \pi \, \frac{1}{N} \sum_j (m_{i,j} + c_j)^2.$$

In this setting, the planner risk attitude, β, governs the assortative matching of the allocation:

$$\{m_{i,j}, c_j\} : i, j = \begin{cases} lli, N+1-i & \text{if} \quad \beta > 0 \quad \text{(negative assortative match)} \\ i, \forall j & \text{if} \quad \beta = 0 \quad \text{(undetermined match)} \\ i, i & \text{if} \quad \beta < 0 \quad \text{(positive assortative match).} \end{cases}$$

Thus, the couple $\{m_{i,j}, c_j\}$ is assigned through a negative assortative matching rule if the planner is risk averse ($\beta > 0$), through an undetermined rule if the planner is risk neutral ($\beta = 0$), and through a positive assortative matching if risk loving ($\beta < 0$). In this context, I proceed under the assumption that the planner is risk averse and verify this prediction empirically.

The board is introduced as a set B of $N/2$ countries, which are randomly assigned to oversee the planner (Adams and Ferreira, 2007). Access to the board changes the incentives for the planner, and I model this in a reduced form through a lump-sum transfer, τ, going from countries not on the board B^C, to countries in B. The parameter τ can have two interpretations, as follows.

1. Rent-seeking – a planner needs to purchase board support to implement actions, and this generates a menu-auction problem (Bernheim and Whinston, 1986; Grossman and Helpman, 1994), which leads to transfer resources toward countries sitting on the board.

2. Technology – countries sitting on the board might be more open to work with the planner, and such increases in communication might lead to a change in returns, justifying the alteration in the optimal allocation.

Given this transfer, whichever justification is taken, the problem presents an important change: the new overall returns are still equal to the previous returns because of linearity, $\widetilde{Y} = Y$. However, the variance of project returns differs and the new problem can be written as

$$\max_{m_i} -\beta \, \pi \, \frac{2}{N} \sum_{j \notin B} (m_{i,j} + c_j + \tau)^2 - \beta \, \pi \, \frac{2}{N} \sum_{j \in B} (m_{i,j} + c_j - \tau)^2.$$

This makes the new allocation dependent on whether a country sits on the board. Therefore, under the risk-aversion assumption, the new allocation is described by

$$\{m_{i,j}, c_j\} \; : \; i,j = \begin{cases} lli, f(\tau, N+1-i) & \text{if} \quad c_j \in B \\ i, f(-\tau, N+1-i) & \text{if} \quad c_j \notin B \end{cases}.$$

This is still negative assortative, but the transfer τ generates a board premium in the manager's assignment, described by the parameter τ and the function $f(.)$. To clarify the intuition behind this result, the main proposition is given here, and Appendix D reports a short example.

Proposition 1 *The optimal allocation of a planner assigning manager i to country j results in: (a) a negative assortative matching rule if risk averse ($\beta > 0$); (b) a manager board premium for countries sitting on the board ($j \in B$), (c) such a premium increasing in the extent of the transfer, τ.*

4.2 Empirical Model

At this point, given that the manager and country performances are estimated through MEs and CEs, I can bring the proposition to the data. To do so, I join the MEs and CEs from the 2,240 sample to the 3,385 sample, which includes projects for countries sitting on the World Bank board. I aggregate the MEs at country–year level and analyze the following expression:

$$ME_{cgt} = a_1 + b_1 \, Board_{cgt} + c_1 \, CE_{cg} + X_{2cgt} d_1 + \iota_g + \iota_t + \varepsilon_{cgt}. \tag{10}$$

Here, the average ME of country c, belonging to constituency group g in year t, ME_{cgt}, is regressed over a board dummy taking unit value when a country c in constituency g in year t sits on the board, $Board_{cgt}$. The level of analysis is at constituency level, and this is embodied by the use of a constituency and year fixed effect, ι_g and ι_t, respectively. The country heterogeneity is caught through two components: the country effect, CE_{cg}, which is constant per country over time and is supposed to catch the direction of manager–country matching, and a few country time-varying controls (GDP per capita, population, exchange rate) X_{2cgt}. The core coefficients are b_1 (to explore whether board access matters) and c_1 (to understand the direction of the assignment).

4.3 Board Election and Exogenous Variation

Before continuing to the empirical results, I need to mention a key institutional feature. World Bank countries, both donors (i.e., high income) and clients (i.e., middle and low income), are allowed to supervise the operations of the World Bank President and senior management. For this purpose, they are joined in relatively small groups, called constituencies, which meet every two years, hold a simple-majority election, and vote two countries for a board seat:

one as Executive Director and another as Alternate Executive Director.[17] By looking at the composition of constituencies, it is clear that the allocation of a country to a group is not random, because there are some clear determinants of constituency selection (e.g., geography, World Bank access year, international status). As is clear from the previous section, in this analysis I exploit only variation at the level of a country within a constituency. Indeed, there is no country fixed effect in equation (8), because this absorbs the estimated CEs, preventing an understanding of the assignment rule.

As mentioned in the introduction, I exploit board election procedures to provide some plausibly exogenous variation in board access. Constituencies are characterized by a differing number of countries and different long-term agreements governing the rotations in the World Bank board (Martinez-Diaz, 2008). While all countries belonging to the 17 voting constituency groups can competitively campaign to reach a board seat, a completely different scenario emerges once a country that has served on the board in the past term tries to be re-elected.

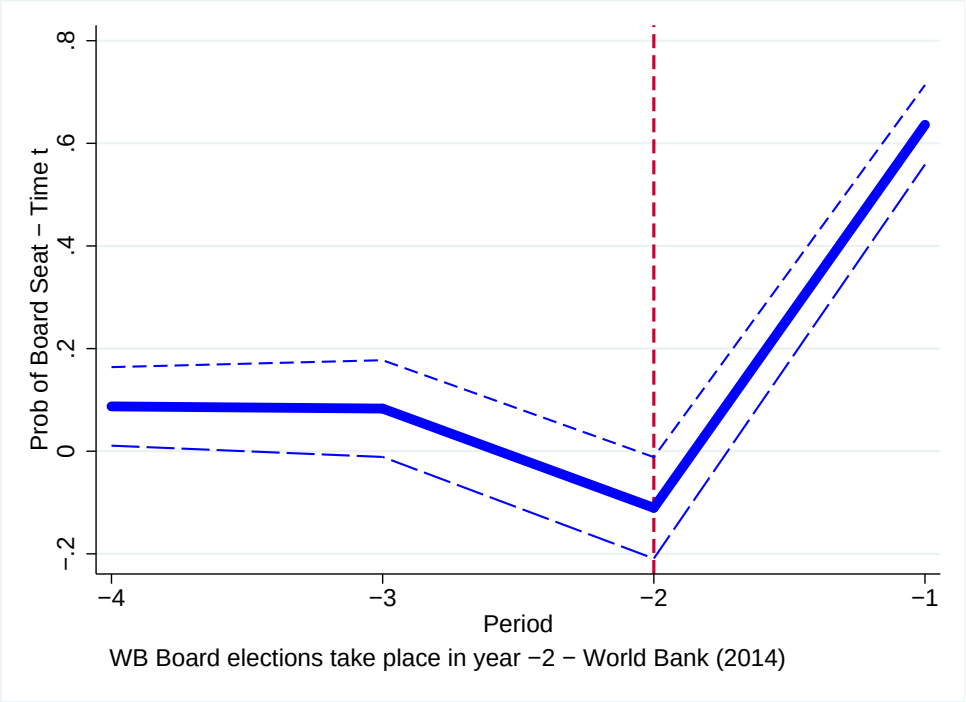
While, in principle, a country serving on the World Bank board should exercise control also on behalf of all other countries in its electoral constituency, this is seldom the case, and there is ample evidence of conflict of interest in this respect.[18] In particular, if a country manages to obtain a board seat for a second term, this can be particularly valuable both because it is possible to influence decision-making and because procedural knowledge of board functioning can provide a strong comparative advantage over newcomers to the board. For example, it is explicitly acknowledged that the longest serving executive director enjoys the title and duties of Dean of the board.[19] In such a capacity, the Dean enjoys strong ties with the President (e.g.,

[17]At least one of these participates in board meetings, with the Alternate Executive Director enjoying voting power only if the Executive Director is absent. In this work, I do not distinguish between the two, as both can supervise and provide their input into a variety of World Bank internal affairs. It is also possible that one country enjoys both positions, although this is generally unlikely. For more details on the procedure, refer to the World Bank's information on "Election or Appointment of Executive Directors" at `http://web.worldbank.org/WBSITE/EXTERNAL/EXTABOUTUS/ORGANIZATION/BODEXT/0,,contentMDK:20124813~pagePK:64020054~piPK:64020408~theSitePK:278036,00.html`.

[18]For instance, the Zedillo Report (Zedillo et al., 2006) highlighted that "the current (World Bank) governance arrangements create strong incentives for (board) Directors to prioritize only their duties as the representatives of governments" (Zedillo et al., 2006, p. 32), and especially, concerning the possible transfer of resources aimed at securing for the World Bank President and Senior Management a strong support in the board, "senior Management has a strong incentive to ensure that the board approves Management proposals quickly and with few changes" (Zedillo et al., 2006, p. 31). Analogous incentives seem to be in place at the IMF, where a 2008 survey (not taken at the World Bank) showed that 68% of former board members admit a conflict of interest in decisions between government interest and the IMF's institutional mission. However, in this work, I take a normative-free stance on the role of boards, and only explore the allocation change that might arise when a country is simultaneously a client and a controller of the lender.

[19]Further information from the Dean of the Board is provided through the page of the current Dean, Kuwait Executive Director, Mr Merza Hussain Hasan. "Our Executive Director is the Dean of the board of Executive Directors. The Dean of the board of Executive Directors is by practice the longest serving, full-time Executive Director. The responsibilities of the Dean include the negotiation of the terms and conditions of the contract of the President along with the Co-Dean. In addition, the Corporate Secretary consults with the Dean during the process of informal consultations to select members of the board Ethics and Standing board Committees. The Dean also chairs the meetings of the Steering Committee, which is the meeting of Executive Directors with Senior Management to set the board's work program and organizes meetings for Executive Directors among themselves or with Management, the UN or other high level experts to exchange views informally. The Dean and Co-Dean of the board also coordinate with the Dean of the Fund's board on matters of mutual interest such as the Annual Meetings, the remuneration of the heads of the two institutions, and corporate governance issues." This information was accessed on October 2, 2015, and is available at `http://www.worldbank.org/`

Figure 7: Probability of Board Election given Previous Board Experience



Note: This figure reports the probability that a country c belonging to constituency group g sits on the board at time t, given that it served on board in the previous year (-1), two years before (-2), and three and four years earlier (-3 and -4). These probabilities emerge from a regression where I control for a constituency and year fixed effect and country–year controls (GDP per capita, population, exchange rate).

the Dean is responsible for negotiating the terms of the President's contract), and has strong agenda-setting power in central board committees.

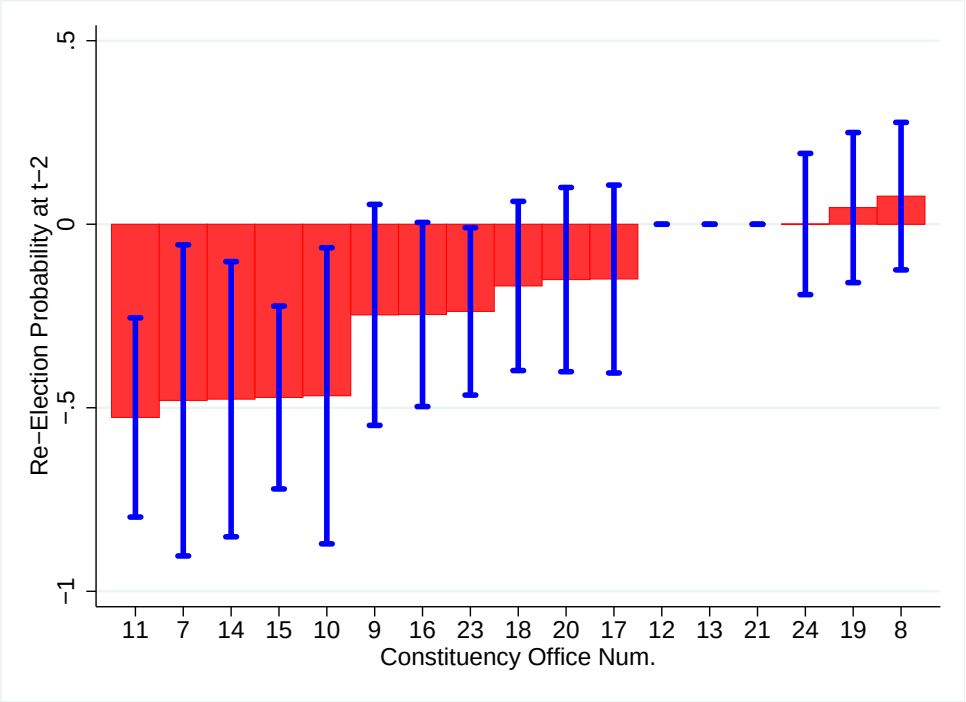
Given the important role emerging from re-election, constituency groups have established some diplomatic norms through long-term agreements on the extent that countries are allowed to run for a second consecutive term. Figure 7 shows the probability that country c belonging to constituency g sits on the board at time t, given that it was sitting on the board during the previous year (-1), two years before (-2), and so on. Because of the two-year board mandate, it is clear that sitting on the board at time $t-1$ predicts period t well.[20] It is also expected that being on the board four and three years ago has a negligible effect on current sitting. However, it is less obvious that if a country was actually sitting on the board in the previous term (i.e., time $t-2$), then it is 10% less likely to sit on the board compared to other countries belonging to the constituency group.

I argue that such negative correlation is due to the different diplomatic norms at constituency level. Indeed, once I control for the heterogeneity of re-election norms at time $t-2$, the negative effect becomes positive in the point estimate but not statistically different from zero, as shown in columns (3) and (4) of Table 10. The heterogeneity in board re-election is displayed in Figure 8, showing that the negative effect is fully given by a few constituencies that present

`en/about/leadership/directors/eds11`.

[20]The point estimate of this probability is 0.6, rather than 1, because there are cases in which a board member may step down – some members are recalled to join their own countries' governments or other organizations, and some voluntarily quit.

Figure 8: Board Re-Election and Constituency Heterogeneity



Note: This figure reports the probability of election for a country c belonging to constituency group g that sat on the board at time $t-2$. This emerges by regressing the country board dummy at time t over the corresponding dummies at $t-1$, $t-2$, $t-3$, and $t-4$, and an interaction between the $t-2$ dummy and constituency group fixed effects, plus constituency and time fixed effects. As clear from the text, the probability of re-election is partitioned into three groups: in the left-most group (constituencies numbered 11, 7, 14, 15, and 10), a country who sat on the board at $t-2$ is 50% less likely of sitting on the board at time t; in the central group (numbers 9, 16, 23, 18, 20, 17, and 12), this probability drops to 20%; for the remaining group, there is no statistically detectable difference between countries who sat on board at $t-2$ and those who did not.

lower probabilities of re-election for their countries: there are five constituencies in which a country previously sitting on the board is 50% less likely than others to be elected; in the other six, this probability is 20%, while for the remaining six, the election is open and competitive at all times.

Therefore, my first stage to instrument board access is given by the following equation,

$$Board_{cgt} = \alpha + \beta\, Board_{cgt-2} + \sum_{g} \gamma_g Board_{cgt-2} \times \iota_g + X_{2cgt} d + \iota_g + \iota_t + \varepsilon_{cgt},$$

in which the probability that a country c in constituency group g sits on the World Bank board at time t, $Board_{cgt}$, is regressed over a dummy for board access in the previous term, $Board_{cgt-2}$, and an interaction between this variable and the constituency group fixed effect, $Board_{cgt-2} \times \iota_g$, the set of country time-varying controls, a constituency group and year dummies, ι_g and ι_t. The fundamental driver for identification is given by $Board_{cgt-2} \times \iota_g$ because it accounts for the heterogeneity in re-election norms.

My exclusion restriction rests on the assumption that conditional on a country's assignment to a constituency and other controls, the heterogeneous diplomatic norms in a constituency have no effect on the current manager's assignment to a country, except through the re-election

Table 10: Board Access and First Stage: OLS

Variables	Board (t)			
	(1)	(2)	(3)	(4)
Board $t-1$	0.647***	0.617***	0.604***	0.569***
	(0.0380)	(0.0394)	(0.0403)	(0.0417)
Board $t-2$	−0.113**	−0.130***	0.145	0.189
	(0.0484)	(0.0474)	(0.124)	(0.121)
Board $t-3$	0.0975*	0.0774	0.0639	0.0423
	(0.0504)	(0.0498)	(0.0510)	(0.0495)
Board $t-4$	0.105***	0.0751**	0.0695*	0.0356
	(0.0391)	(0.0382)	(0.0390)	(0.0379)
Board $t-2$ × Constituency FE			Yes	Yes
Constituency FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Controls		Yes		Yes
Observations	1,347	1,347	1,347	1,347
Test			0.000***	0.000***
Adjusted R^2	0.426	0.441	0.442	0.459
Mean Dep. Var.	0.182	0.182	0.182	0.182
Std Dev. Dep. Var.	0.386	0.386	0.386	0.386

Note: This table reports OLS estimates. The unit of observation is country–year level and standard errors in brackets are clustered by country × year. Columns (1) and (3) report unconditional results, while in columns (2) and (4) I control for population, GDP per capita, and exchange rate. Board t takes unit value if country c in constituency g sits on the World Bank board in year t, and analogously board $t-1$, $t-2$, $t-3$, and $t-4$. In all regressions I control for constituency and year fixed effects. In columns (3) and (4), I include an interaction between board $t-2$ and the constituency fixed effect in order to measure the heterogeneous probability in board re-election, established by diplomatic norms. The estimates of column (4) of such interactive fixed effects are reported in Figure 8. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

probability this country enjoys in the constituency. A major concern here would be that the heterogeneous re-election probabilities in a constituency are correlated with its bargaining power with the World Bank and, hence, I am simply capturing its impact on a manager's assignment. I believe this is unlikely for at least three reasons. First, constituencies do not have other formal ways of voicing their opinion to the World Bank administrative bodies, except through their board members. Second, among the 25 constituency groups, those holding elections enjoy, generally, less bargaining power with the World Bank. In fact, the strongest constituencies in terms of voting power are the eight single-country constituencies, which appoint their board members directly – they enjoy a total vote share of 46.59%,[21] equivalent to an average share of 5.8% per country. In contrast, the remaining 17 constituencies enjoy a substantially lower vote share (i.e., 3.1% per constituency group), which then is further diluted in single-country vote shares. Third, because in the computation of the CEs I am excluding all countries that permanently sit on the World Bank board, this analysis excludes countries that may have strong

[21]These countries are the United States of America (16.12%), Japan (7.47%), China (4.82%), Germany (4.37%), France (3.92%), United Kingdom (3.92%), Saudi Arabia (3.02%), and Russia (2.95%). For data regarding International Bank for Reconstruction and Development (IBRD) vote share in 2013, refer to `http://siteresources.worldbank.org/BODINT/Resources/278027-1215524804501/IBRDEDsVotingTable.pdf`.

bargaining power with the World Bank (China, India, Russia, Bangladesh, and Argentina).

4.4 Results

Table 11 presents the core results, with columns (1) and (2) reporting the OLS estimates, while columns (3) and (4) report IVs; columns (1) and (3) report unconditional results, while in columns (2) and (4) I also report controls. First, it is evident that a country sitting on the World Bank board seems to enjoy managers with a higher effect in all cases. Secondly, there emerges evidence of negative assortative matching, with the sign of the CE variable being unambiguously negative and statistically different from zero.

Concerning the difference between the OLS and IV estimates, the latter are 40%–70% larger than the OLS, which might be entirely due to a local average treatment effect (LATE): this IV captures variation in assigned managers for countries that enjoy a seat on the board for a second period. Because institutional experience might give a stronger leverage for countries in manager assignment, this coefficient is expected to be larger. The board and CE magnitudes highlight that a country with a full point of FE above the average can eliminate the negative assortative matching by sitting on the World Bank board. As a relatively secondary point, it is important to highlight that because the CE is a generated regressor, I use the Murphy and Topel (1985) correction for the standard errors through a bootstrapping procedure.[22]

4.4.1 An Additional Prediction of the Model

While Proposition 1(a) and (b) are brought to the data through Table 11, here I extend Proposition 1(c) to the data. Conceptually, I assume that the transfer decreases in the number of countries belonging to the constituency, $\tau(n_g)$. This is based on the fact that the leverage of a board member in extracting better managers might increase with voting power, which is a positive function of the number of constituents. At the same time, this implies that constituents who are not on the board have more to lose, and therefore might implement a stronger monitoring of their board member.

Therefore, the slightly richer equation reported here embodies this scenario, and presents an interaction between board access with the number of countries present in a constituency

[22]The generated regressor problem emerges when a right-hand side variable is generated through a previous regression. Because this regressor includes a point estimate and a standard error, the OLS estimator yields consistent estimates but invalid standard errors, as highlighted by Pagan (1984) and Murphy and Topel (1985). Statistical inference based on such standard errors tends to reject the null hypothesis. For this reason, I follow the approach proposed by Murphy and Topel, using a two-step bootstrapping algorithm to compute the standard errors of this regression; this is also in line with the work of Ashraf and Galor (2013). The bootstrap procedure is as follows. (1) In the first stage, a random sample with replacement is extracted, containing 90% of the observations. (2) This sample is used to derive a vector for MEs and CEs, as shown in Table 1. (3) Points 1 and 2 are repeated 1,000 times, leading to 1,000 vectors of MEs and CEs. (4) For each ME and CE vector, the second-stage regression presented in Tables 10 and 11 is run on a random sample, containing 90% of the observations, and these coefficients are stored. (5) This procedure is repeated 1,000 times also in the second stage. (6) The standard deviation of each coefficient from the second-stage stored distribution is used as the bootstrapped standard error for each variable.

Table 11: Manager–Country Assignment: Country-Level Evidence

Variables	Manager Effects			
	OLS		IV	
	(1)	(2)	(3)	(4)
Board	0.182***	0.152***	0.317***	0.215*
	(0.033)	(0.031)	(0.083)	(0.094)
CEs	−0.238***	−0.261***	−0.252***	−0.262***
	(0.037)	(0.037)	(0.037)	(0.036)
Constituency FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Controls		Yes		Yes
Observations	1,347	1,347	1,347	1,347
First-Stage AP F			45.63***	23.11***
Adjusted R^2	0.0721	0.0764	0.0663	0.0753
Mean Dep. Var.	0.0107	0.0107	0.0107	0.0107
Std Dev. Dep. Var.	0.661	0.661	0.661	0.661

Note: This table reports OLS estimates in columns (1) and (2) and IV estimates in columns (3) and (4). The unit of observation is country level and standard errors in brackets are corrected using the Murphy and Topel (1985) procedure through bootstraps. Columns (1) and (3) report unconditional results, while in columns (2) and (4) I control for population, GDP per capita, exchange rate, interest rate, IBRD projects, and approval month. Manager Effects denotes the vector of fixed effects (FE) extracted from a regression of Project Outcome as presented in Table 1, column (1). The MEs are then aggregated at country–year level, while the CEs are country-specific and time-invariant. The mean and standard deviation of the left-hand side variables are reported in the final two rows. Board is a dummy variable taking unit value if a country c belonging to constituency group g sits on the board in year t, and zero otherwise. In the IV estimates, this is instrumented through the probability of re-election in the previous term, $t-2$, interacted with the constituency fixed effects as presented in Section 4.3. Constituency group fixed effects and year fixed effects are included throughout this analysis. The row First-Stage AP F reports the results of the First-Stage Angrist–Pischke F-test on the relevance of the instrument; in both cases, the IV equation presents an F above 20, considered to be a benchmark case for a strong instrument. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

group, $Num.Countries_{gt}$:

$$\begin{aligned} ME_{cgt} &= a_2 + b_2\, Board_{cgt} + c_2\, FE_{cg} + d_2\, Board_{cgt} \times Num.Countries_{gt} \\ &\quad + e_2\, Num.Countries_{gt} + X_{2cgt}d + \iota_g + \iota_t + \varepsilon_{cgt}. \end{aligned}$$

The increasing nature of the manager premium in the extent of the transfer is caught by the term d_2, which I expect to be negative and statistically different from zero given the previous argument. As is clear from Table 12, this is indeed the case and the interaction is negative and statistically different from zero. The main coefficient on the board increases substantially, while the number of countries, per se, does not affect manager assignment. Conceptually, Tables 11 and 12 are not very different, which is also the case in terms of magnitude: if the interactive coefficient is multiplied by the average number of countries in a constituency (13.67), then it is clearly seen that the average point estimate on the board dummy is indeed unchanged. However, it is interesting to note that countries sitting on the board in small constituencies tend to receive managers with a substantially higher effect than other countries, while countries

Table 12: Manager–Country Assignment: Country-Level Evidence

Variables	Manager Effects			
	OLS		IV	
	(1)	(2)	(3)	(4)
Board	0.430***	0.383***	1.038***	0.938***
	(0.075)	(0.072)	(0.176)	(0.199)
Board × Num. Countries	−0.0210**	−0.0191**	−0.0697***	−0.0655***
	(0.005)	(0.005)	(0.013)	(0.015)
Number of Countries	0.00873	0.0111	0.0240	0.0240
	(0.010)	(0.011)	(0.010)	(0.011)
CEs	−0.245***	−0.265***	−0.266***	−0.274***
	(0.037)	(0.037)	(0.035)	(0.035)
Constituency FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Controls		Yes		Yes
Observations	1,347	1,347	1,347	1,347
Mean Dep. Var.	0.0107	0.0107	0.0107	0.0107
Std Dev. Dep. Var.	0.661	0.661	0.661	0.661

Note: This table reports OLS estimates in columns (1) and (2), and IV estimates in columns (3) and (4). The unit of observation is country level and standard errors in brackets are corrected using the Murphy and Topel (1985) procedure through bootstraps. Columns (1) and (3) report unconditional results, while in columns (2) and (4) I control for population, GDP per capita, exchange rate, interest rate, IBRD projects, and approval month. Manager Effects denotes the vector of fixed effects (FE) extracted from a regression of Project Outcome as presented in Table 1, column (1). The MEs are then aggregated at country–year level, while the CEs are country-specific and time-invariant. The mean and standard deviation of the left-hand side variables are reported in the final two rows. Board is a dummy variable taking unit value if a country c belonging to constituency group g sits on the board in year t, and zero otherwise. In the IV estimates, this is instrumented through the probability of re-election in the previous term, $t-2$, interacted with the constituency fixed effects as presented in Section 4.3. Number of Countries reports the number of countries belonging to constituency group g at time t. Constituency group fixed effects and year fixed effects are included throughout this analysis. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

in large constituencies (the historical maximum is 25) tend to receive no statistically different increase in their management assignment.

5 Concluding Remarks

In this paper, I study the role of managers in World Bank project success and explore the resource allocation problem faced by the World Bank in assigning its project managers to countries. Building on the valuable work of Denizer, Kaufmann, and Kraay (2013), who pioneered the study of World Bank managers on project success, I join their insights with a few methodological concepts from other fields to study these issues. First, I adapt the teacher value-added empirical framework to identify manager effects (MEs) as managerial performance and country effects (CEs) as an index public good provision. Secondly, on the data side, I join the World Bank Project Rating Database with information on manager identities and their corresponding CV characteristics. In this part I find that manager effects have a variance higher than country

effects. This is a surprising result, because it implies that the World Bank systematically hires individuals with a dispersion in managerial performance exceeding the dispersion in recipient countries' public good provision.

In order to show that such manager and country effects contain information content in line with the interpretations of managerial performance and country's public good provision, I verify that MEs correlate with some individual predetermined characteristics, which can be considered predictors of high productivity (e.g., study field, advanced degrees, work experience). Similarly, I verify that CEs are correlated with institutional measures (e.g., parliamentary democracy, constraints on the executive, ethnic fractionalization, slave trade, legal origins, and PIM index).

Having focused on a positive analysis, I suggest a reform to improve the World Bank effectiveness by assigning the 10% worst-performing managers to non-project bureaucratic tasks, and replacing them with average managers. This exercise is made possible by the availability of several economic indicators at project level: the USD amount of each project, its interest rate, the ERR, among others. By combining the ME information with these indicators, I can estimate the gains achievable by replacing a few (66) under-performing managers without an explicit firing operation, which might induce general equilibrium effects. Overall, my results suggest that such a reform leads to the creation of an additional 800 million USD of returns generated by the World Bank over the sample under analysis, corresponding to a 3.7% increase. At the same time, by consulting World Bank documentation, I am able to provide plausible cost scenarios to evaluate the viability of the reform, which would deliver net gains of 624 (426) million USD under a moderate (extreme) cost scenario, with the range included between 38 and 1,011 million USD.

At this point, I study the manager–country allocation through a theoretical framework, which highlights two components as key to affecting resource allocation: the planner's risk attitude and the presence of countries on the World Bank board. I show that a risk-averse planner intends to minimize the variance of project returns, and hence adopts a negative assortative matching and allocates higher productivity managers to lower productivity countries. At the same time, countries sitting on the World Bank board might receive better managers than otherwise, for which there can be two explanations: (1) countries on the board are more capable of extracting rents from the planner; (2) countries on the board can improve their communications/relations with the planner. At this point, I present a plausibly exogenous source of variation for access to the World Bank board. This is given by the diplomatic norms governing the re-election of countries, and shows that different constituency groups are characterized by heterogeneous rules that prevent or allow a country to run for re-election. Finally, I present the main results and find evidence of negative assortative matching and of a manager premium emerging for those countries sitting on the World Bank board.

All in all, this work contributes to the development literature with a clear message: understanding public organization can provide valuable policy lessons and their organizational reform may be as powerful as countries' own institutions. Although development lending is

hard to assimilate with the aid debate, both bodies of literature have often highlighted that the poor institutions of recipient countries should be blamed for the inability of countries to take advantage of aid and development lending resources. Numerous academics, policy makers, and commentators have suggested radical reforms for the institutional setting of countries, regardless of these being largely top-down, possibly undemocratic, and probably destined to fail. In this work, I revert the focus of this debate and argue for the need to reform the organization of development lenders, and possibly aid donors. Through a cost–benefit analysis, I show that this seems to be an obvious, readily achievable target.

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