

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

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Abstract

Deposit volatility and costly bank liquidity increase the long-term lending rates offered by banks, which reduce loan maturities, long-term investment and output. We formalize 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 toward working capital. A targeted liquidity programme is quantified to generate yearly output gains between 0.042% and 0.205%.

JEL: G21, O16, O12, E58

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1 Introduction

Long-term finance is widely regarded as key to promoting long-term investment and economic growth (Gerschenkron (1962), World Bank (2015)). Its supply is a traditional function performed by the banking system, which converts short-term and liquid deposits into long-term and illiquid loans. Whereas a sizeable literature has related the financing frictions experienced by banks to a lower credit supply and underinvestment, much less is known about the conditions under which maturity transformation may fail and the bank supply of long-term loans weaken.

This paper shows that volatile deposits and costly liquidity (high discount rate) affect disproportionately the bank cost of supplying long-term lending because of a liquidity risk. For instance, small stochastic deposit withdrawals can be covered by the bank with its inside liquidity at no extra cost, whereas large withdrawals force borrowing from the central bank (or an interbank market) at a premium rate. Therefore, a high volatility increases such expected cost, particularly for loans extending over a long maturity, during which multiple shocks could take place. As a result, the spread between the long- and short-term lending rate increases in deposit volatility and the cost of liquidity, leading firms to lower loan maturities, long-term investment and output.

Emerging market economies are likely to be particularly affected by this mechanism for two reasons. First, they exhibit a high deposit volatility, due to a larger reliance on agriculture and fewer formal sector jobs. Indeed, there exists a negative relationship between deposit volatility and the level of development (Figure 1, left panel), in line with the results on income volatility Koren and Tenreyro (2007). Second, their financial institutions tend to be underdeveloped, with local liquidity being an expensive and scarce commodity. As a result, the positive relationship between the maturity of bank loans and the level of development (Figure 1, right panel) and the debate on the low supply of long-term finance in emerging markets (World Bank (2015)), are consistent with this explanation.

Our empirical analysis explores a unique natural experiment providing 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 to 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 redepositing afterwards. Second, the value of the threshold: Sharia law defines the wealth threshold as the price of 612.32 grams (52 tolas, a local measurement unit) 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 Pakistani rupee (PKR) 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 larger gains from engaging in withdrawal-and-redeposits than individuals further away from it. We observe that due to social stigma and temporary deposit disintermediation, such phenomenon of withdrawal-and-redeposit begins 2-3 months prior to

the payment and ends only after 2-3 months. Because 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 the silver price volatility, the wider the range of possible realizations that the final drop can take. As a result, the bank may be surprised by a larger volume of withdrawals than expected, forcing substantial borrowing from the central bank, which increases the expected costs of liquidity for banks and 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 measure 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 automated teller machine (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. If the distribution of deposits of a bank lies above the threshold, while that of another lie below, then the former is more affected by the withdrawal-and-redeposit phenomenon. Hence, in absence of information on the distributions, we rely on the average deposit amount and define the ratio between the average deposit in a bank and the threshold as an alternative source of cross-sectional variation. 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, 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 us 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 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 find that two margins are key: 1) a long-to-short redirection, with a decline of loans with a maturity of

five years or more, and an increase of those with a one-year maturity; 2) a short-to-very-short redirection, with an increase in loans with a maturity of three 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 religious obligations, but without uncertainty on withdrawals originated by silver prices. Thus, we replicate our empirical strategy for this alternative period and cannot reject the null hypothesis of no 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 programme neutralized the Zakat uncertainty on deposit volatility by temporarily lowering liquidity costs? To address this, we combine the theoretical model with the elasticities from the loan-level analysis. We find that the output gains of this policy lie between 0.042%, based on the ATM share estimates, and 0.205%, based on the deposit ratio estimates.

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 (e.g., deposit insurance, multiregional diversification, multinational banking) can promote long-term finance and investment. Third, establishing and promoting financial institutions in emerging markets (e.g., interbank markets, discount windows) can lower long-term lending rates by allowing commercial banks to smooth deposit shocks. In particular, we argue that central banks in low-income countries 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 present stable discount window facilities.

This paper adds 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, which has focused on the first moment of bank liabilities,² with an emerging literature that is focusing on depositor

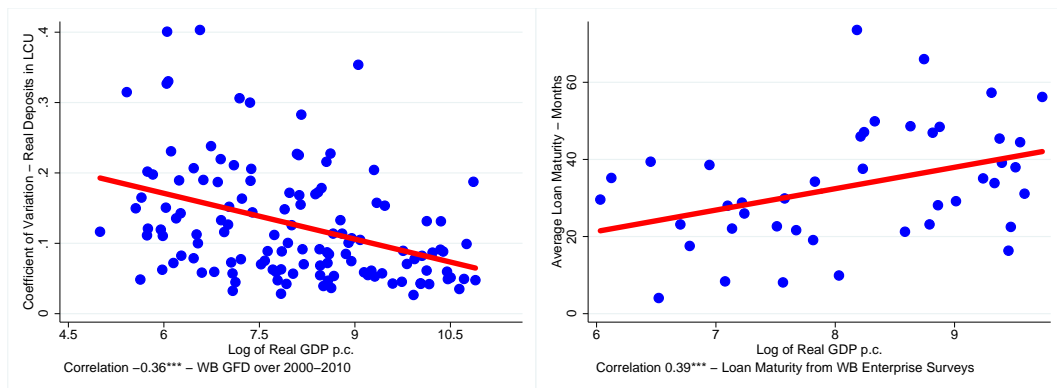
¹This literature was pioneered by [Levine \(1997\)](#), [Caprio Jr and Demirguc-Kunt \(1998\)](#) and [Diamond \(2004\)](#), and more recently developed by [Qian and Strahan \(2007\)](#) and [Bae and Goyal \(2009\)](#).

²[Paravisini \(2008\)](#) studied how exogenous changes in government-to-bank loans affect the supply of credit, [Schnabl \(2012\)](#) investigated how bank-to-bank loans affect a variety of loan characteristics, and [Khwaja and Mian \(2008\)](#), [Bustos et al. \(2016\)](#) and [Gilje et al. \(2016\)](#) studied 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 \(forthcoming\)](#).

behaviour.³ Third, our paper 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 checks and placebo. In Section 4 we comment on the policy implications of our research and elements of external validity. Finally, in Section 5, we present concluding remarks.

Figure 1: Deposit Volatility, Loan Maturities and Development



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 in local currency unit (LCU) on the y -axis. The correlation between these two variables is -0.36 and is statistically different from zero at 1%. The right panel reports 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. 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)); bank deposit data are from the Global Financial Development (GFD) database available in World Bank (2015). Both are between the years 2000 and 2010. Finally, the average loan maturity data are from the World Bank (WB) Enterprise Surveys.

2 Theoretical and Empirical Framework

2.1 Theoretical Framework

A solid literature has related the role of bank deposits/liabilities and their shocks to lending and assets (Diamond and Dybvig (1983), Kashyap et al. (2002), Hanson et al. (2015)). In this section, we report such insights in a tractable and simple model. This presents two advantages. First, it is sufficiently simple to allow a mapping of the Zakat shock to deposit volatility as one parameter, the variance of a deposit shock, which drives our comparative statics and empirical analysis. Second, this model offers a laboratory to assess the effect of deposit volatility and liquidity on lending, investment and outcome. We combine the results of this specific model to the empirical elasticities found in section 3 to calibrate the output losses due to Zakat in section 4.

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

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

⁴For empirical references for the former, see Allen and Gale (2004), Allen et al. (2009); for those for the latter, see Bernanke and Gertler (1989), Bernanke and Blinder (1992), Kashyap and Stein (2000), Jiménez et al. (2012).

given in period 1 and repaid in period 2, whereas long-term loans are given in 1 and repaid in 3. All prices are given, and 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} , as in [Bolton et al. \(2011\)](#) and [Prisman et al. \(1986\)](#). 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 presents only two maturities (short and long), whereas in a more general model there would exist a continuum. The literature has shown that with a multiperiod 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.) uniformly, $\varepsilon \sim U[-v, v]$. 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 more productive technology in the long term than in the short term (their $\rho_i > p$), whereas others are endowed with a relatively 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 firm

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

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, $L_{1,2}$ and $L_{1,3}$, 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, $D_{2,3}$, 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. \(1986\)](#).

For each period, the loan supply and deposit demand of the bank emerge by solving

$$\begin{aligned} \max_{D_{1,2}, D_{2,3}, L_{1,2}, L_{1,3}} & (r_{L1,2}L_{1,2} + r_A A_{1,2} - r_{D1,2}D_{1,2}) + \delta (r_{L1,3}L_{1,3} + r_A A_{2,3} - r_{D2,3}D_{2,3}) + \\ & + \delta r_{CB} \int_{D_{2,3} - L_{1,3}}^v (D_{2,3} - L_{1,3} - \varepsilon) f(\varepsilon) d\varepsilon \end{aligned}$$

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 periods 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.

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, and 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 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 state⁶ 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 local interpretations of the Sharia law, is calculated using the international price of silver and corresponds to the value of 612.32 grams (52 tolas, a local measurement unit). One central characteristic related 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 is above the threshold by 1 PKR, 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 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 US dollars (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 wealth threshold over

⁶Refer 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).

⁷Refer to the work of the Charities Aid Foundation, [World Giving Index 2015](http://www.givingindex.org/).

⁸In 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 Ramadan, 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>).

the period 2002 to 2010 corresponds to 25,856 PKR, converted approximately into 250 USD. This is particularly small, given that in the same period, the average gross domestic product (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 the 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 began offering silver futures and options in only mid 2011 (after the period of 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; 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 hypotheses are met in the data:

1. the overall level of deposits does not change, there occurs only a temporary dip;
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 us 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 available only for the years 2007 to 2014, and therefore, in this section we restrict ourselves to this period. We define a dummy variable, called *Zakat 6-months*, which takes unit value for the three months before and three months after payment of the Zakat.

⁹See the statistics on silver for 2012 to 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 began activities on 11 May 2007 and offered the first silver future contracts on 31 May 2011 – read more at http://www.pmex.com.pk/broker/documents/20-2011_-Listing_of_Silver_100_Ounces-3005-2011.pdf.

Table 1 indicates that, although the level of deposits does not change over the whole period (column (1)), banks acquire substantial liquidity injections by the State Bank of Pakistan, which increase by approximately 37% (column (2)). While it is possible that banks adjust also through other margins (e.g., holding more cash), the data in Table 1 show 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 1 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). Column (4) also shows 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 2 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 approximately 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 particularly 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 be expected to generate much larger deposit-and-withdrawals. Institutional details help to clarify some of the reason behind this limited decline in deposits. First, there is a certain level of social stigma against evading this levy, and individuals may not feel completely comfortable being viewed repeatedly cashing out their deposits. Second, Pakistan is characterized by a high share of charitable donations,¹¹ and some individuals may be indifferent between offering their private donations, via withdrawals, or donating through the public obligation. Third, the cost of storing substantial cash may be very high and discourage the withdrawals of extremely large amount. Last, but not least, wealthy individuals may avoid this levy by temporarily dis-intermediating their deposits either directly, by receiving cash payments for the preceding months, or indirectly, by transferring their deposits into alternative financial assets (e.g., bonds, stocks), which are exempt from this levy. As a result, although

¹⁰To 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, which implies a shortfall of 79.5 billion PKR. In the same period, central-bank injections go up by 37%, introducing 43.5 billion PKR. As a result, on average, the central bank covers 54.7% of the deposit shortfall.

¹¹Refer to the work of the Charities Aid Foundation, [World Giving Index 2015](#).

the lack of depositor-level data does not permit us to describe clearly the individuals involved in such “withdrawal-and-redeposit” phenomenon, we can be comfortable stating that the notch generated by the levy combined with anecdotal evidence and Figure 2 suggest that the effect may be activated by a large number of depositors around the threshold. To put all this 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.

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. To calculate a variable that describes deposit volatility, we go from a weekly analysis on the level of deposits, to a monthly analysis on their 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.

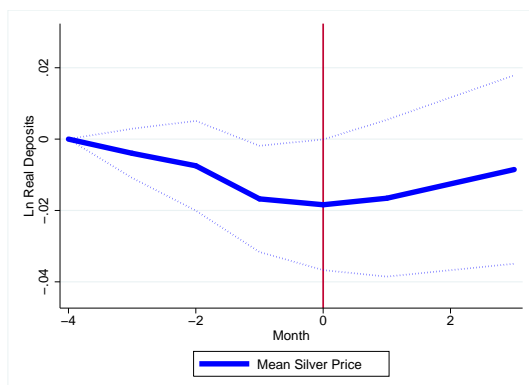
Table 1: Deposits, Liquidity and Zakat

	(1)	(2)	(3)	(4)
Variables	Bank Deposit Ln(PKR)	SBP Liquidity Injections Ln(PKR)	Bank Deposit Ln(PKR)	Bank Deposit Ln(PKR)
Zakat 6-months	-0.00254 (0.00297)	0.369** (0.158)		
Zakat 1-month			-0.0184*** (0.00277)	-0.0188*** (0.00282)
Zakat 1-month × Silver μ_t				0.004*** (0.002)
Zakat 1-month × Silver σ_t				0.0005 (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 (FE). The years analysed are 2007 to 2014. Robust standard errors are in parentheses. The dependent variables are the natural logarithm (Ln) of the real bank deposits in billion of 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* takes unit value for the month before the payment of the Zakat levy. The *Silver μ_t* and *Silver σ_t* are, respectively, the standardized mean price of silver and the 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 2: 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 report the deposit behaviour given the average price of silver over the period 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 (0.396)	0.760* (0.424)	0.665 (0.423)
Zakat - 3-months × Silver σ_t		0.530** (0.226)	0.581** (0.229)
Silver σ_t		-0.0423 (0.133)	-0.109 (0.134)
Zakat - 3-months × Silver μ_t			0.283 (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 to 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, and this is 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 is standardized to take mean zero and unit standard deviation; the respective actual mean is 0.007, and standard deviation is 0.005. Moreover, the silver price volatility variable is standardized 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.

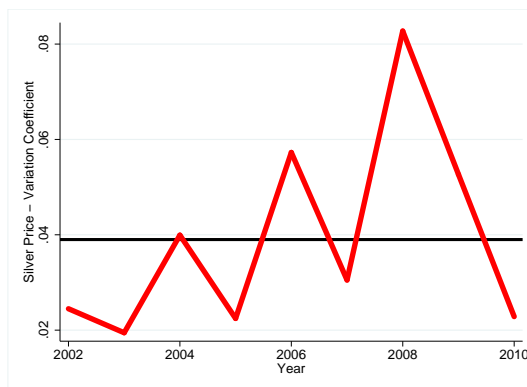
We define a new dummy, *Zakat 3-months*, which takes unit value for only those three months before the obligation. This is regressed over the volatility of bank deposits, including interactions both with silver price volatility and mean. Table 2 shows that during the three months before Zakat, there is a general increase in volatility, by around 0.5 standard deviations, and in particular this grows in the interaction between the Zakat dummy and silver price volatility: a 1 standard deviation increase in silver price volatility, during the three months before Zakat, generates an additional 0.5 standard deviation increase in deposit volatility. Conversely, we do not find a significant effect for just the level of silver volatility outside Zakat or the level of silver in general. Overall, in this section we show 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 with 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 of 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 3: The Volatility of Silver Prices – 2002 to 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 through 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.

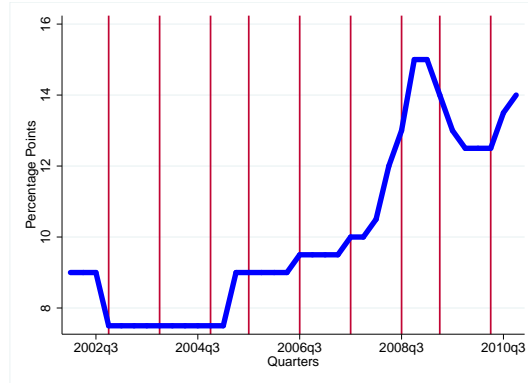
Time-Series Variation

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. Figure 3 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 the range 2–8%. As discussed in Appendices 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 3 are mostly due to low liquidity on international markets or to periods of volatile silver demand. The sudden swings in this variable generate useful variation for our identification.

Figure 4: 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%, with a standard deviation of 2.43, a minimum of 7.5% and a maximum of 15%.

Discount Rate and State Bank of Pakistan

Replacing deposits with central-bank liquidity can be expensive in Pakistan. As shown in Figure 4, the average discount rate between 2002 and 2010 was 10%, in the range 7.5–15%. This generated a 5% average premium on liquidity, 2.5–10 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. 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 exploit its interaction only 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 4 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

because of 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, the State Bank of Pakistan 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:¹²

“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 SBP’s [State Bank of Pakistan’s] policy rate, which will remain at 13 percent. These issues are likely to determine SBP’s policy trajectory in the coming months.”

It is particularly interesting to analyse this statement for two reasons. First, there was explicit recognition of the liquidity tightness as Ramadan approached and the Zakat payment was 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 the fact that the monetary policy rate is constrained not to change because of the Zakat obligation.

Cross-Sectional Variation

The extent to which the Zakat contribution affects banks depends on how much the banks are exposed to the withdrawal-and-redeposit phenomenon. 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, and *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.¹³ The majority of Muslim Pakistanis adhere to the Sunni school (76%), with the remaining 19% belonging to the Shia.¹⁴

¹²See page 2 of the Monetary Policy Statement, available at [http://www.sbp.org.pk/m_policy/MPD-29-Sep-09\(English\).pdf](http://www.sbp.org.pk/m_policy/MPD-29-Sep-09(English).pdf)

¹³Refer 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>.

¹⁴Derived 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.

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,¹⁵ whereas Shia Pakistanis have been allowed to contribute their Zakat individually since the mid 1980s.¹⁶ 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 ATMs per city of every bank in each year between 2002 and 2010. This map is superimposed onto the religious map of Pakistan produced by Dr M. Izady and the Columbia University Gulf/2000 project.¹⁷ 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 to 2014 and define it as $Exposure_b$.

Deposit Ratio

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 wealth threshold, banks with a higher average deposit amount will experience a larger withdrawal of funds.

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 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

¹⁵The 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*, “Zakat exemption limit doubled”, <http://www.dawn.com/news/647723/zakat-exemption-limit-doubled>.

¹⁶This 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.

¹⁷This religious map is available from http://gulf2000.columbia.edu/images/maps/Pakistan_Religion_1g.png and is based on a combination of historical data, census information and online documentation. To cross-validate the content of the map, we compare the aggregate numbers with the 1998 Census data collected by the Pakistan Bureau of Statistics and find that these sources are aligned. For more on this, refer to PBS.

the average amount deposited relative to the wealth 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 limited 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.

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

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; 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 1 standard deviation increase in silver price volatility for a bank that is 1 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 1 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, that is, the investment in fixed capital and working capital. Equation (2) is key to our estimation:

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

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 provides only an aggregate picture, which although imperfect, is in line with the 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.¹⁸ 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 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.

¹⁸Reported in the publication under “Appedix-VII [*sic*] Bank Wise ATM’s 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.

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 3 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 from 2002 to 2010 from 30 banks to 24,972 firms.¹⁹

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 not correlated 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; 2) the deposit ratio, which varies per bank over time and we observe 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 the mean and standard deviation of silver prices. Both these variables vary at quarter-year level. Panel D reports the summary statistics for the bank-level controls. Finally, Panel E reports

¹⁹Choudhary 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 of 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.

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

Variables	(1) Observations	(2) Mean	(3) St. Deviation	(4) Minimum	(5) 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. The *ATM Share* summarizes the share of ATMs held in Sunni-majority areas. The second index of exposure is given by the *Deposit Ratio*, measured as the ratio between the average deposit of a bank and the threshold. Panel C shows summary statistics on the discount rate and the price of silver. The first variable is defined by the quarterly meeting of the Pakistan central bank. The second row of Panel C reports the coefficient of variation of silver, while the third shows 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. The *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 *Ln Tot. Assets* is the total 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. The *Total Investment* is defined as the growth rate in firm assets net of depreciation, *Fixed Capital* is the growth rate in fixed assets net of depreciation and *Working Capital* is 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, in which we report the bank exposure through the ATM share in columns (1) to (3), and that through the deposit ratio in columns (4) to (6). The first term in the table, $Zakat_{bt}$, represents the effect of a 1 standard deviation increase in silver price volatility, for banks with a 1 standard deviation higher exposure, when the discount rate lies at its minimum rate (7.5%). The second term, $Zakat_{bt} \times Rate_t$, adds to the previous effect the effect of a 1 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 onto creditors, even if loan conditions do not change. In fact, the coefficients in the first row show 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 points in column (5)) without changing loan sizes.

However, when central-bank liquidity is more expensive, the equilibrium loan changes along both average maturity and rate. Columns (1) and (2) indicate that banks that are 1 standard deviation more exposed through the ATM share, in presence of a 1 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) exploit the deposit ratio exposure by banks and 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 the 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 Figure F1 and Figure F2 report the linear predictions of the effect, as emerging from Table 4. In Appendix G, we show the same pictures, 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, which is in the range 12–15% (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, r_{CB} , is zero, then deposit volatility has no effects on lending.

Table 4: Zakat and Loan Characteristics - Bank Controls

	(1)	(2)	(3)	(4)	(5)	(6)
Variables	Maturity Ln(Days)	Lending Rate	Loan Ln(PKR)	Maturity Ln(Days)	Lending Rate	Loan Ln(PKR)
$Zakat_{bt}$	0.034 (0.022)	0.296** (0.121)	-0.008 (0.027)	0.090 (0.069)	0.711** (0.305)	-0.138 (0.243)
$Zakat_{bt} \times Rate_t$	-0.023** (0.010)	-0.132** (0.052)	-0.001 (0.013)	-0.144** (0.055)	-0.692** (0.313)	-0.020 (0.185)
Exposure	ATM Share	ATM Share	ATM Share	Deposit Ratio	Deposit Ratio	Deposit 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
FE b, f, t, ft, bf, bq	Yes	Yes	Yes	Yes	Yes	Yes
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 bank, firm, time (quarter-year), firm-time, bank-firm and bank-quarter (to account for bank-specific seasonalities), as reported in the third-last row “FE”. Standard errors are clustered at bank-time level; the number of clusters is 816 in columns (1) to (3) and 383 in columns (4) and (6). The *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; *Loan Ln(PKR)* 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 of 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. This 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 1 standard deviation increase in silver price volatility for banks that are 1 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 1 standard deviation increase in the discount rate. Columns (1) to (3) report the bank exposure to Zakat through the *ATM Share* using the standardized share of branches in Sunni-majority cities. Columns (4) to (6) report 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 for the year. The bank-level controls reported here vary at the t level and are the capital to assets ratio, the 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 are reported in the fifth- and fourth-last rows, respectively. 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 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 of banks with a low exposure to individuals who have a positive probability of withdrawal. Conversely, the deposit ratio exposure provides a measure of the intensity of the withdrawals around the wealth threshold. In principle, this control group may not necessarily coincide with that is described by the ATM share, therefore explaining 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), whereas 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- and bank-level controls and interactions with the discount rate. This does not affect our results. Second, the Zakat payment can have an effect not only on banks’ uncertainty over a very high deposit withdrawal (the core of this paper), but also over the temporary decline in deposits (level effect). We address this in the following three ways: 1) we always control for the level of deposits measured at quarterly frequency in the regressions (normalized by the share of assets); 2) we take care of the expected deposit decline by using bank–quarter fixed effects; 3) 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 Table 1 and Table 2, because the first moment of silver has an effect on the first moment of deposits, and 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 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 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; 6) all the previous controls together. Although we observe some changes in the point estimates, the results are qualitatively unchanged. Fourth, our sample includes the 2008 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; 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 those of 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 3.1 , we extract from the universe of Pakistani corporate lending (approximately 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, we are unable to use some loans: from missing one or more key variables, to reporting no borrower or bank code, to obvious typing errors (e.g. maturities with missing or invalid numbers). In Appendix O we show that this measurement error is not correlated with our Zakat variables: this is achieved by regressing a dummy variable that takes 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 tests showing that the results of our mechanism are heterogeneous across different firms. In Table P1 we show that firms with a larger lending volume tend to be less affected, although the magnitudes are small: only those firms that are between 5 and 10 standard deviations above the mean are immune to volatility. Conversely, we see that firms that take more loans but not necessarily larger loans are not differentially affected. In Table P2 we show that firms with a higher share of collateralization are comparatively less affected, but again with small magnitudes, while we show that in case a firm presents a credit rating (assigned either by the bank itself or a third-party), then this 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 four and five years) increase more than those with a short maturity and that 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, but 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; five years or more), and interact these with our Zakat variables.

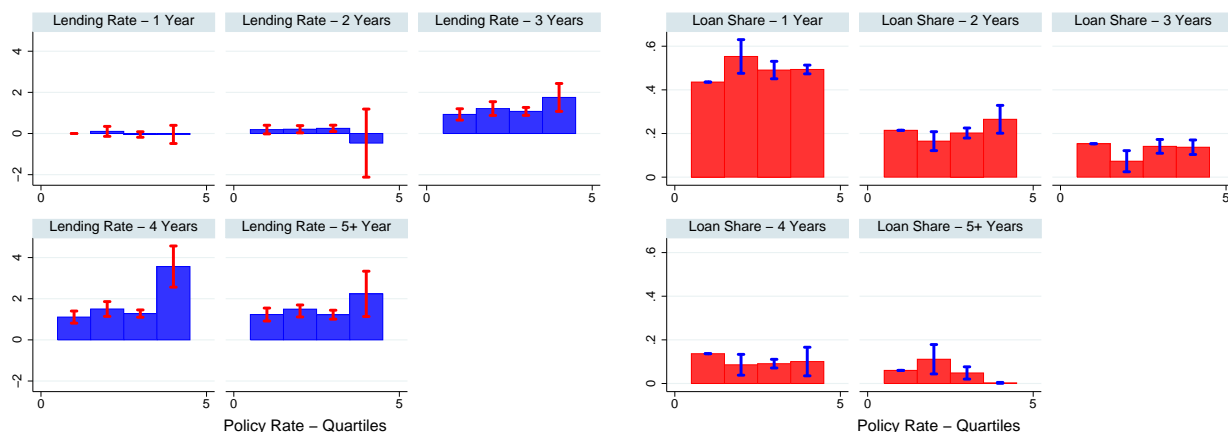
2. An equation at bank level, in which we observe at every time t the share of loans given by each bank in every maturity class, which are regressed on the variables as in equation (1).

We use these results to quantify the output effect of Zakat in Section 4.

The left panel of Figure 5 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, and five years or more all increase by around 2.5 points in presence of a 1 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 right panel of Figure 5 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; 2) there is a corresponding increase in loans given at maturity of one year or less and two years. Therefore, this more aggregate bank-level analysis confirms our findings. This is not a 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 5: 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 which case, loans with a maturity of three, four, and five or more years show a significant increase in their lending rates. 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* takes unit value if a loan is originated-and-repaid before the first day of Ramadan, when the Zakat levy is applied. These are 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, although we still employ the Zakat variation along the ATM share and deposit ratio exposures, we introduce only bank, firm and time fixed effects. The results, in Table 5, are consistent with the hypothesis of a reallocation of toward very-short-term loans. A 1 standard deviation increase in silver price volatility and discount rate leads banks that are 1 standard deviation more exposed to increase their probability of

giving loans with a maturity of 3 months or less, by 0.23% along the ATM share exposure, and by 4.05% along the deposit ratio exposure. Finally, there occurs also an increase in the probability of loans given and repaid before Zakat: a 1 standard deviation increase in silver volatility leads more-exposed banks to increase their probability of giving such short loans by 0.42% under the ATM share exposure and by 0.62% under the deposit ratio exposure. These effects increase 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 a positive effect on deposit rate, as predicted by the theoretical model and highlighted in Appendix A. Although the point estimate is positive, we are unable to reject a 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 (0.0022)	0.0042* (0.0022)	0.0139 (0.0240)	0.0062** (0.0025)
$Zakat_{bt} \times Rate_t$	0.0023* (0.0010)	0.0020 (0.0012)	0.0405* (0.0211)	0.0033 (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 is 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 time (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 columns (1) and (2) and 383 in columns (3) and (4). The *Maturity 3 Months or Less* is a dummy variable taking unit value for all loans with a maturity less than three 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 of 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. This 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 1 standard deviation increase in silver price volatility for banks that are 1 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 1 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 for the year. The bank-level controls reported here vary at the t level and are the capital to assets ratio, the 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 are reported in the fifth- and fourth-last rows, respectively. 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.

Table 6: Zakat and Firm Investment - Firm Controls

Variables	(1)	(2)	(3)	(4)	(5)	(6)
	Fixed Assets	Working Capital	Total Investment	Fixed Assets	Working Capital	Total Investment
$Zakat_{ft}$	0.010 (0.015)	-0.004 (0.013)	0.001 (0.007)	0.020 (0.077)	-0.082 (0.105)	-0.037 (0.068)
$Zakat_{ft} \times Rate_t$	-0.020 (0.040)	0.015 (0.049)	-0.006 (0.023)	-0.085** (0.040)	0.111* (0.063)	0.012 (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. The *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. This 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 1 standard deviation increase in silver price volatility for banks that are 1 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 1 standard deviation increase in the discount rate. The bank exposures to Zakat are reported in the row “Exposure”. Columns (1) to (3) report estimates using the *ATM Share*; columns (4) to (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 are reported in the fifth- and fourth-last rows, respectively. 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 the estimates using ATM share (columns (1) to (3)) and the estimates using deposit ratio (columns (4) to (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 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 1 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 1 standard deviation higher bank exposure (19% of 1 standard deviation) and to an increase in working capital of 0.11 points (19% of 1 standard deviation). Appendix R reports two additional specifications of Table 6: 1) excluding all firm-level controls; 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 period of low fixed asset investment.

3.3 Identifying Assumption and Robustness

Our identifying assumption is that the interaction between silver price volatility and the discount rate affects the loan choice between long term and short term through only the reaction in their corresponding rates, given by the heterogeneous banks' exposures. 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 that provides the details of each test.

Placebo – Eid Adha Celebrations Silver price volatility may have 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 capturing an effect only 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 shown in Table 4 and Table 6.

To address this potential issue, we offer a placebo test to show that the interaction between silver price volatility and the discount rate affects loan characteristics around only 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,²⁰ and consumption of meat and other goods.²¹

The most relevant factors behind this placebo are: 1) there are large deposit withdrawals (1.2%, as shown in Table T2); 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 analysing 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 in equation (1). 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 above argument applies, then we should observe an abnormal decline (or increase) in banks’ overall operations during the quarter immediately preceding 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; 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 in the case of the ATM share in Panel A and in the case of the deposit ratio in Panel B, in both of which there does not emerge any movement in the overall activities of banks. Therefore, we find that, even if there may be selection in the timing of loans during the Zakat period, it does not appear 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. To limit the withdrawal of funds from the central bank at expensive rates, banks may time the repayment

²⁰There 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 celebration 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>.

²¹See 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>).

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 al-Adha celebration, discussed in the previous section.

Alternative Explanation on the Quality of Lending A competing argument to our mechanism may be 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 shown 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); 3) the share of loans with customers presenting a rating previously given by the bank. In Appendix V, we 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 relates 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 the long-term rate 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 section “Bank Competition and Deposit Volatility” of Appendix B); 3) consistently with this second point, we do not observe a reallocation of loan amounts across banks (which goes against the initial argument); 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, to analyse 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 that have 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 a 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 this section, we evaluate a policy response to the deposit volatility generated by Zakat, and discuss the external validity of this work.

We analyse the effect of a special liquidity programme operated by the central bank to neutralize the Zakat effect. In general terms, this specific shock is useful to highlight to what extent and how central banks can intervene and support the supply of long-term finance through their liquidity operations. However, given this specific shock and its relationship to silver prices, a market alternative could be available if the central bank relaxed its commodity-trading regulations.²² While this is true for the specific Zakat shock and other shocks that are tied to market-insurable events, it is true that most banks in emerging markets rely mostly on the central bank for emergency liquidity, and we decide to focus on this specific facility for our analysis.

4.1 Quantifying the Effect of a Targeted Liquidity Programme

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

Exploiting the assumptions made in section 2 and discussed in detail in Appendix A, we can quantify the output effects of Zakat by using information from only 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 reach the expressions

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

²²For example, banks could hedge against this shock by purchasing both call and put options on silver prices. In the period 2002 to 2010, this was limited by the lack of a mercantile exchange platform, which started offering similar products from 2011 onward. However, even from 2011 onward, banks seem to use very moderately such financial products. One reason behind this could be the relatively high cost of these options and the fact that each bank account should be insured against such fluctuations. Given the low amounts held on the average bank account (868 USD) and the high cost of such insurance per account (400–600 USD), the market option may be too costly for banks.

which, respectively, quantify how the output in the economy, \bar{Y} , and the average maturity, \bar{M} , change in presence of deposit volatility v for a given discount rate r_{CB} . In these expressions, the subscript m reports the maturity class of a loan (1 year or less; 2 years; 3 years; 4 years; 5 years or more), as introduced in Section 3.2.2. 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 we estimate in Section 3.2.2. Similarly, the expression for maturities is the sum of the product between the loan share and the rate response.

Table 7 reports the main results of this section, given the average silver price volatility, and combining both the ATM share exposure and the deposit ratio exposure. 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 programme would lead to an average increase in loan maturities: 4.71% under the ATM share exposure, and 22.79% under the deposit ratio exposure. 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%, which is within the interval of our estimates, by generating a reallocation away from research and development (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. In this respect, an intervention by the central bank to contain liquidity costs temporarily 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 programme to address this narrowly defined problem. At the same time, although our methodology allows us to use information from exclusively the credit registry, this comes at the cost of accepting the specific assumptions of the model (e. g., functional forms of firms' productivity and shock, perfect competition in production and

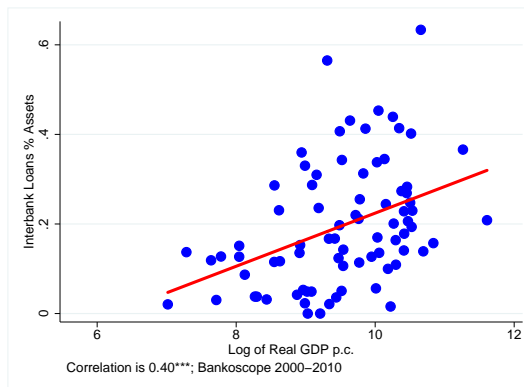
finance), which may limit the generality of the current exercise. Finally, we are not accounting for the possible side effects of this policy (e.g., inflation, moral hazard), which may depend on the execution of the liquidity programme.

Table 7: Output Gains of a Targeted Liquidity Programme

(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 programme 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 6: Interbank Markets and Development



Notes: This figure 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 Bankscope database; data are aggregated for a country and between 2000 and 2010. The correlation between these two variables is 0.40 and is statistically different at 1%. In both cases, the log of real GDP per capita is taken from Penn World Tables.

4.2 External Validity and Policy Implications

This mechanism is likely to be more relevant in emerging market economies, given that their deposits tend to be more volatile (Figure 1, left panel).²³ At the same time, this is amplified by the limited functioning of local financial institutions, which amplifies deposit shocks by not allowing banks to smooth shocks.

For instance, local interbank markets tend to be very small or non-existent. Figure 6 shows a scatter plot between the average share of bank assets placed in interbank claims per country and their level of development. Two features are evident: 1) there exists a positive correlation between the interbank market use and development; 2) interbank markets simply do not exist in most countries with very low levels of income.

²³As discussed in [Koren and Tenreyro \(2007\)](#), low-income countries present a higher volatility of income because of both 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.

Beyond this, banks in emerging markets cannot use international capital markets, either because of local regulation or low international reputation. At the same time, most of their central banks are either legally unable or *de facto* 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 International Monetary Fund / 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, $r_{CB} \rightarrow \infty$. This makes long-term finance infinitely costly for banks, and generates extensive redirection toward the short term.

These elements are 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), from which two important messages emerge: 1) access to long-term finance is a supply problem (75% of respondents agree); 2) domestic banks play the most important role in access to long-term finance (61% of respondents agree). Our paper contributes to this debate by arguing that the malfunctioning of liquidity markets and central banks is a key problem.

5 Conclusions

In this paper, we propose a mechanism through which the interaction between bank deposit volatility and liquidity cost can alter banks' funding costs. The higher the cost of accessing outside liquidity to replace volatile deposits (e.g., from the central bank), 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 with a unique natural experiment in deposit volatility. For this purpose, we exploit the payment of a Sharia levy on bank deposits, the 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 section 4, 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. To

evaluate this programme, we combine the theoretical and empirical results by 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 exposure. Such a 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 in emerging markets, the lack of functioning liquidity markets and central-bank institutions may be key. Further research in the field of banking and development will allow us to extend these results and provide more refined guidance toward optimal policy.

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