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

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Abstract

Deposit volatility lowers loan maturities in the presence of costly bank liquidity, which in turn reduces long-term investment and output. We formalise this mechanism in a banking model and analyse exogenous variation in deposit volatility induced by a Sharia levy in Pakistan. Data from the universe of corporate loans and a firm-level survey show that deposit volatility and liquidity cost: 1) reduce loan maturities and lending rates; 2) leave loan amounts and total investment unchanged; 3) redirect investment from fixed assets towards working capital. A targeted liquidity program is quantified to generate yearly output gains between 0.042% and 0.205%.

JEL: O12, G21, O16, E58

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1 Introduction

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

We develop a novel explanation based on bank intermediation and the role of deposit volatility in the presence of costly bank liquidity. Our mechanism, the "bank maturity channel", is illustrated through a banking model and tested in Pakistan, exploiting exogenous variation in deposit volatility on the universe of corporate loans and a firm-level investment survey. Throughout the paper, we refer to the discount rate as the cost paid by banks to replace deposits with central bank liquidity.

The theoretical framework focuses on the maturity-transformation of banks, which convert short-term deposits into long-term loans. The "bank maturity channel" highlights that volatile deposits and a high discount rate redirect the economy toward lower output, by lowering long-term finance and investment. The interaction between the cost of central bank liquidity and deposit volatility is key, because it creates a non-convexity in bank funding costs. For instance, small stochastic deposit withdrawals are covered by the bank with its liquidity at no extra cost, whereas large withdrawals force borrowing from the central bank at a premium rate. Deposit volatility therefore affects disproportionately the bank cost of supplying long-term loans because of a maturity mismatch risk. As a result, the equilibrium spread between the long- and short-term lending rate increases in the interaction between deposit volatility and the discount rate, leading firms toward short-term projects and lower output.

A unique natural experiment provides exogenous variation in deposit volatility with which we can empirically assess our mechanism. Zakat is a recurring contribution that Muslims are expected to provide 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. Two features of this obligation are central in creating deposit volatility: 1) value of the threshold – Sharia law defines this threshold as the current value of 52 tolas (612.32 grams) of silver, and Pakistani authorities announce its exact value only 48–72 hours before collection. Therefore, the *de facto* threshold is the product between the international price of silver in the announcement day and the Sharia-compliant silver quantity; 2) timing – the levy is applied on only those deposits held in banks on the first day of every Ramadan. As a result, 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. Therefore, the lower the international price of silver, the stronger the wave of withdrawals and redeposits as more people pass the eligibility threshold; whereas the opposite applies for a high price of silver.

Our identification exploits the volatility in silver price in the quarter before the Zakat payment as a source of exogenous variation for the volatility of the corresponding deposit drop. Although banks can match on average the deposit drop, they cannot predict with precision the announced threshold and, therefore, the final extent of the drop. As a result, in years of high silver price volatility, the exact final drop could have a wider range of values. This results in high expected costs of alternative liquidity for banks, which are passed onto borrowers through higher lending rates, which generate the bank maturity channel. Our reduced-form evidence on deposit volatility combines the volatility in the international price of silver with two measures of bank exposure to Zakat, as described in detail in Section 3. The first uses the extensive margin of Zakat, which exploits the exemption of some religious groups from the levy and, hence, their lack of withdrawal-and-redeposit. This is measured by combining the geographic variation in branch exposure at bank level, with a detailed religious map of Pakistan. The second measure is based on the intensive margin and uses bank-level information about how close the average depositor lies to the threshold. These two identifications lead to qualitatively analogous estimates, with larger magnitudes observed under the intensive margin.

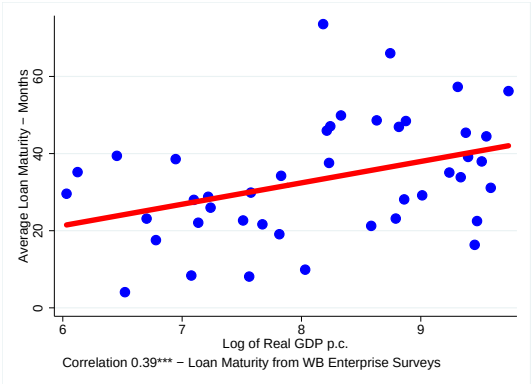
Beyond the natural experiment, a credible investigation of this mechanism requires the local availability of high-quality documentation regarding banks' balance sheets and a credit registry. Also in this respect, Pakistan is the ideal country because its central bank, the State Bank of Pakistan, has kept a detailed credit registry for more than a decade. 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 and exploit within-bank-firm and across-bank variation, as pioneered by Khwaja and Mian (2005, 2008), to separate loan supply from demand. Complementing these datasets with a detailed survey of firm investment permits to further analyse how changes in financial characteristics affect real variables.

In the presence of a high silver price volatility and discount rate, we find a drop in loan maturities, which increases with bank exposure to Zakat. In the same context, the average lending rate drops, in line with the predictions of the theoretical model: as the long-term lending rate increases, firms switch from a "high-maturity–high-lending rate" product to a "low-maturity–low-lending rate" product. Finally, in terms of loan characteristics, we do not observe movements in the amounts borrowed. We further investigate the financing redirection and two margins are found to be key: 1) a long-to-short redirection, with a decline of loans with a maturity of 4 years or more, and an increase of those with a 1-year maturity; 2) a short-to-very short redirection, with an increase in loans with a maturity of 3 months or less, and loans that are originated-and-repaid before the levy. To characterize how firms' investment responds to Zakat, we match a detailed firm-level survey with the loan-level data. This verifies that firms linked to banks that are more exposed to Zakat do not alter their overall investment amount, but change its composition with a decline in fixed capital investment and an increase in working capital. We subsequently quantify a policy counterfactual answering the following question: how would output respond if a targeted liquidity program neutralized the Zakat effect by temporarily lowering liquidity costs? In order to address this, we combine the theoretical

model with the elasticities from the loan-level analysis. Our results find that the output gains of this policy lie between 0.042%, based on the extensive margin estimates, and 0.205% on the intensive margin ones.

Although the existence of this mechanism does not depend on the income level of a country, its extent and economic costs are likely to be more relevant in low-income countries (LICs) for four reasons: 1) their financial systems are mostly bank-based; 2) their banks are mostly deposit-funded; 3) their deposits are more volatile and 4) their financial systems exhibit high discount rates or, often, non-existent interbank markets and central bank liquidity facilities. For these reasons, although the results of our analysis are specific to Pakistan, this work offers three policy implications that extend beyond this context. First, the interaction between the volatility of bank deposits and the discount rate can reduce long-term finance and investment by altering banks' lending incentives. In particular, we find that monetary policy can promote a reallocation of maturities toward the short term through its liquidity operations and discount rate. Second, government intervention can moderate bank deposit volatility and policy-induced uncertainty in deposit withdrawal, for example by introducing deposit insurance, promoting multinational banks and eliminating deposit-market frictions. Third, enhancing financial institutions in LICs can directly promote long-term finance and investment. In particular, we argue that central banks in LICs need to guarantee a stable, reliable and accessible source of liquidity to the banking system. In this respect, we collect new data about the local availability of discount window facilities in Africa and note that most African banks do not have access to any alternative liquidity to deposits and that more than 50% of African central banks are unable, or unwilling, to provide liquidity.

Figure 1: Loan Maturities and Development



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

This paper participates to three debates. First, it contributes to the literature on long-term finance and development by showing that volatile deposits and the cost of liquidity can generate a redirection of loan maturities and firm investment toward the short term.[1] Second, this is the first paper to introduce and study a natural experiment on loan supply generated by a change

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

in the second moment of bank liability, contributing to a literature that has focused on the effects of bank liquidity and shocks to the first moment of bank liabilities on lending.[2] Third, it further examines the role of financial institutions in completing markets (Allen and Gale (2004), Allen et al. (2009)) and monetary policy on real variables by adding our bank maturity channel mechanism to the classical bank balance-sheet channel (Bernanke and Gertler (1989)).[3]

In Section 2, we introduce the bank maturity channel through a theoretical framework. In Section 3, we discuss the empirical framework and identifications, including the heterogeneous exposure of banks, and we present the main equations to be estimated. In Section 4, we describe the data and present the main results and robustness checks. Section 5 offers some remarks about the policy implications of our research and elements of external validity. Finally, we present conclusions in Section 6.

2 Theoretical Framework

In this section, we examine a three-period model with three agents: a household leaving short-term and volatile deposits in the bank, heterogeneous firms investing in short- and long-term projects, and a bank intermediating short-term deposits with short- and long-term loans. All prices are given and there is perfect competition and common knowledge.

The key 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 more the long-term lending rate rises, which encourages firms to reduce long-term finance and hence long-term investment and output.

Two forces generate this result. First, the fact that depositors withdraw a stochastic amount after the bank has given out long-term loans, which introduces deposit volatility as the standard deviation of this withdrawal. Second, the inefficiency generated by 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 cost is zero; if the withdrawal is large, it needs to borrow from the central bank at a positive rate. This non-convexity is key because it allows the second moment of the deposit withdrawal to have an impact.

Therefore an increase in deposit volatility, given a non-zero cost of liquidity, leads to a higher marginal cost of funding, which is reflected proportionately more on longer-term loans. This leads to a more than proportional reduction in the long-term lending supply, which pushes up the equilibrium long-term lending rates. As a result, firms switch from a high-maturity and high-lending rate loan to low-maturity and low-lending rate one.

[2] Paravisini (2008) studies how exogenous changes in government-to-bank loans affect the supply of credit, Schnabl (2012) investigates how bank-to-bank loans affect a variety of loan characteristics, and Khwaja and Mian (2008), Bustos et al. (2016), Drechsler et al. (2016) and Gilgje et al. (2016) study how changes in the level of deposits affect credit, exploiting a variety of alternative identification strategies. Refer also to Iyer and Peydro (2011), Banerjee and Duflo (2014), Jiménez et al. (2014), Paravisini et al. (2015), Garicano and Steinwender (forthcoming).

[3] For empirical references, refer to Bernanke and Blinder (1992), Kashyap and Stein (2000), Jiménez et al. (2012).

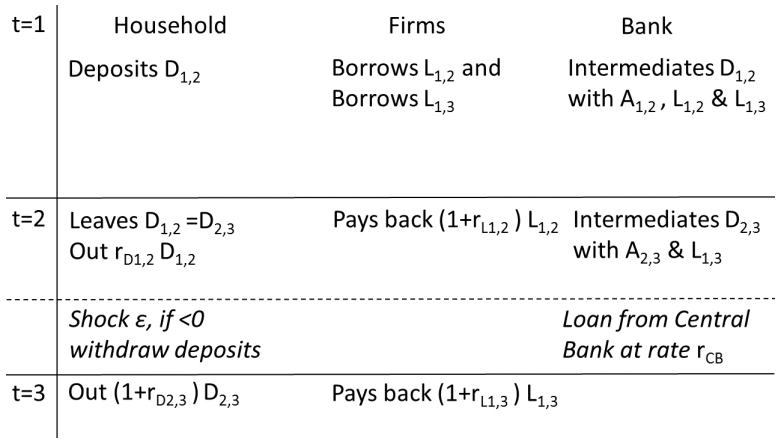
While this model is simple enough to illustrate this point in a competitive equilibrium setting, with closed forms and testable implications, it is unable to provide predictions over the whole interest rate term-structure. In a more general setting, for example Cox et al. (1985), there could be reallocations both from long-term to short-term loans and also between short- and very short-term loans depending on the volatility-generating process. Both of these results are consistent with the our framework, however in the interest of tractability, we focus on a simpler testable model.

Figure 2 illustrates the timing of the game and the agents. Most of the essential algebraic derivations can be found in Appendix A.

Household

For tractability, we do not let the household make a deposit choice, and instead assume that it leaves deposits D at the bank both between periods 1 and 2 and periods 2 and 3, taking out only the interest for consumption. We normalize such deposits to 1, so $D_{1,2} = D_{2,3} = D$ and $D = 1$.[4] The timing assumption is crucial. In the morning of $t = 2$, the household is reimbursed with the interests on the old deposits, $r_{D1,2}$. Whereas 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 special feature involving deposit volatility between periods 2 and 3 is given by a stochastic deposit supply in the second period $\widetilde{D}_{2,3} = 1 + \varepsilon$, in which we assume that the shock is independent and identically distributed (i.i.d.) and simplify the distribution to a uniform case, $\varepsilon \sim U[-v, v]$. Therefore, all its moments are finite, with $E(\varepsilon) = 0$ and $V(\varepsilon) = \frac{v^2}{3}$. The parameter v embeds the standard deviation of deposits, which we henceforth refer to as deposit volatility.[5]

Figure 2: Timing of the Model



Notes: This figure reports the timing of the model. There are three periods, $t = 1, 2, 3$, and three players: a household, a continuum of firms and a bank. The full horizontal line separates between periods, and the dashed line indicates the existence

[4] We leave the household deposit in the banking system unchanged, $D_{1,2} = D_{2,3}$. However, this equality does not affect the results of the model; it only buys simplicity. In Appendix B we extend the model and remove such equality.

[5] Because $D_{2,3} = 1$ and the only source of savings in this economy is households, v is naturally bounded to be below 1. If v exceeded 1, then households would become net borrowers of the bank, and this would hit the resource constraint because in this simple setting the bank has no other available liabilities. In this model we focus on a bank engaged in intermediation.

of a "morning and evening" in period 2. The first column shows the household behaviour. In period 1 it leaves $D_{1,2} = 1$ at the bank (subscripts indicate that deposits are given in period 1 and mature in period 2). At $t = 2$, the household withdraws the interest, leaving again $D_{2,3} = 1$. Finally, in period 3 it withdraws the deposits and interests. However, in the evening of period 2, the household is affected by a shock ε; if this is negative, then it withdraws funds from the bank. The second column reports the behaviour of a unit continuum of firms. Because of technological heterogeneity, some firms take short-term loans $L_{1,2}$ (given in period 1 and expiring in period 2) and some long-term loans $L_{1,3}$. At $t = 2$, firms investing in the short term repay, whereas the others repay in period 3. The third column indicates the bank. In period 1 it intermediates deposits, $D_{1,2}$, with short- and long-term loans and a safe asset, respectively $L_{1,2}$, $L_{1,3}$ and $A_{1,2}$. In period 2 it intermediates deposits $D_{2,3}$ with safe assets $A_{2,3}$ and refinances the long-term loans $L_{1,3}$. Finally, in period 3 it repays depositors and is reimbursed by firms. The key aspect is given by the evening of period 2, in which if ε is negative and higher than the liquidity held by the bank, $A_{2,3}$, then a loan is requested to the central bank at rate r_{CB}, which is the premium on the cost of liquidity (the difference between the discount rate and the deposit rate).

Firms

There exists a unit continuum of firms, and each solves an investment allocation problem. Because of indivisibility, each firm i chooses to invest in either a short- or a long-term project. Both are *ex ante* observable: the short-term investment delivers a net return $p < 1$, and the long-term project delivers a heterogeneous return ρ_i, uniformly distributed between 0 and 1, $\rho_i \sim U[0, 1]$. Both are deterministic and known at the moment of the investment decision. Intuitively, ρ_i can be thought of as a draw of technology: some firms are endowed with a comparatively more productive technology in the long term than in the short term (their $\rho_i > p$), whereas others are endowed with a less productive technology.

Because of observability, the bank knows all parameters before the investment decision, and therefore 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 $r_{L1,3}$.[6] Technology fixes the maximum size of each project to one; therefore $L_{i1,2} + L_{i1,3} = 1$.

Appendix A shows the solution for the firm problem, which leads to individual firm loan demands. By aggregating both short- and long-term functions over the continuum, we can describe the aggregate demands

$$L^D_{1,2} = \frac{p + \delta r_{L1,3} - r_{L1,2}}{\delta} \quad \text{and} \quad L^D_{1,3} = 1 - \frac{(p + \delta r_{L1,3} - r_{L1,2})}{\delta}$$

and note that an increase in $r_{L1,3}$, holding constant $r_{L1,2}$, δ and p, generates a redirection of lending from the long to the short term. Similarly we can define the average maturity and overall output in this economy through

$$\overline{M} = 2 - r^*_{L1,3} \quad \text{and} \quad \overline{Y} = p\, r_{L1,3} + \frac{1}{2}\left(1 - r^2_{L1,3}\right)$$

which integrate the individual firm choice for maturity and project return over the continuous (see Appendix A).

[6] In this model we explicitly leave out the possibility of firms financing a long-term project with a series of short-term loans. Our model takes for granted a result from the theoretical literature showing that the maturity of the assets (investment project) should match that of the liabilities (financing loans). Hart and Moore (1994) provide conditions under which this is true, and Milbradt and Oehmke (2015) show in a general equilibrium setting that firms end up choosing optimally and simultaneously the same maturity for this.

Bank with Volatile Deposits

The banking model is based on the work of Prisman et al. (1986), on deposits and recourse. Whereas they consider a monopolistic bank acting in one period, we extend the model to a competitive setting, with rates emerging from market clearing and a three-period model. At $t = 1$, the bank receives one-period deposits from the household in period 1 to be repaid in period 2, $D_{1,2}$, and allocates these into assets: loans $L_{1,2}$, $L_{1,3}$ and a liquid and safe asset $A_{1,2}$. In the morning of $t = 2$, the bank earns $r_{L1,2}L_{1,2}$ from firms investing short term and $r_A A_{1,2}$ from the safe asset and pays the household interests $r_{D1,2}D_{1,2}$, which are withdrawn while the deposit level stays unchanged, now $D_{2,3}$. Such liabilities are 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.

Therefore the loan supply and deposit demand of the bank emerge by solving

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

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, for simplicity) must equal the sum of the assets, both liquid and loans. In Appendix A we derive the first-order conditions (FOCs) of this problem and show the results of a benchmark case without volatility.

Deposit Volatility

The household is subject to an i.i.d. income shock ε after $D_{2,3}$ is left with the bank in the second period and the bank has allocated its assets. If the shock is negative, then a withdrawal takes place. For a sufficiently small negative shock, the bank covers this with its liquidity; otherwise it accesses a refinance facility through the central bank and borrows 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, $D_{2,3} - L_{1,3} > \varepsilon$. Given that $E(\varepsilon) = 0$, then the bank's objective function becomes

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

Through the uniform distribution, the last term simplifies to $\frac{[v-(D_{2,3}-L_{1,3})]^2}{4v}$, and the FOCs from this exercise describe the loan supply and deposit demand of the bank in both periods. 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, and this problem falls back to the benchmark case presented in Appendix A.

Market Clearing

A competitive equilibrium with free entry is characterized as an allocation $(A_{1,2}, A_{2,3}, L_{1,2}, L_{1,3})$ and a vector of interest rates $(r_A, r_{D1,2}, r_{D2,3}, r_{L1,2}, r_{L1,3})$ such that, in the presence of price-taking: 1) there is no arbitrage in safe assets; 2) short-term investment delivers zero profits; 3)

the short and long-run excess loan demands equal zero; 4) the short and long-run excess deposit demands equal zero and 5) the bank makes zero expected profits. The algebra for this can be found in Appendix A, and the main results are presented here. This competitive equilibrium with deposit volatility leads to the following equilibrium lending rates:

$$r^*_{L1,2} = p \quad \text{and} \quad r^*_{L1,3} = \frac{2v}{r_{CB}+2v} p\left(1+\frac{1}{\delta}\right) + \frac{r_{CB}}{r_{CB}+2v} v$$

with corresponding allocations $(A_{1,2}, A_{2,3}, L_{1,2}, L_{1,3}) = (0, r^*_{L1,3}, r^*_{L1,3}, 1 - r^*_{L1,3})$.

Note that, as shown in Appendix A, the equilibrium long-term lending rate increases with volatility and that such increase grows in the discount rate. Moreover, in Appendix A, we define the average lending rate, loan maturity and output and note that, although loan maturities and output are unambiguously declining in deposit volatility, the average lending rate in this economy can respond ambiguously to a deposit volatility increase because of the interplay of two effects: a positive, given by firms continuing to borrow long-term despite the higher rate; and a negative, given by firms switching to cheaper short-term loans. All these results can be summarized in the following proposition.

Proposition *There exists a parameter region for* $v < p\left(1+\frac{1}{\delta}\right)$, $r_{CB} \in (0, 2v]$ *and* $\delta > \frac{2vp}{r_{CB}(1-v)+2v(1-p)}$ *such that an increase in deposit volatility,* v*, generates:*

** a change in loan characteristics, corresponding to: an increase in the long-term lending rate,* $\frac{\partial r_{L1,3}}{\partial v} > 0$ *and a decrease in the average maturity of loans,* $\frac{\partial \overline{M}}{\partial v} < 0$

** a change in the investment profile of firms, including: a decline in the long-term lending and investment share,* $\frac{\partial L_{1,3}}{\partial v} < 0$*, and an increase in the short-term lending and investment share,* $\frac{\partial L_{1,2}}{\partial v} > 0$

** a resulting decline in overall output,* $\frac{\partial \overline{Y}}{\partial v} < 0$*.*

All these effects on the role of deposit volatility increase with the discount rate; therefore $\frac{\partial^2 r_{L1,3}}{\partial v \partial r_{CB}} > 0$, $\frac{\partial^2 L_{1,3}}{\partial v \partial r_{CB}} < 0$, $\frac{\partial^2 L_{1,2}}{\partial v \partial r_{CB}} > 0$, $\frac{\partial^2 M}{\partial v \partial r_{CB}} < 0$ *and* $\frac{\partial^2 Y}{\partial v \partial r_{CB}} < 0$*. 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.*

Three points require further discussion. First, all the maturity-reallocation effects in this model are equilibrium results and not the attempt of the bank to avoid a withdrawal. Second, in this simplified setting an increase in volatility leads to an increase in the long-term lending rate and no changes in the short-term rate. In a richer model both rates could depend on volatility, however the main intuition of this model is likely to be in place and generate an increase in the spread between the long- and the short-term rate in response to higher volatility. Third, in the interest of tractability, this model only presents two maturities (short and long), while in a more general model there would exist a continuum of maturities. In such model, depending on the underlying setting and the assumptions on the volatility-generating process, there could be both effects of reallocation from the long- to the short-term and other reallocations from the short- to the very short-term. In the empirical section we show that both of these results are in place and our current model embeds both of these without explicitly distinguishing the two.

In addition to these predictions, in Appendix A we show that also the deposit rate changes in response to volatility. In Appendix B we offer three extensions of the model to verify how this reacts to: 1) a deterministic deposit withdrawal in absence of volatility; 2) a deterministic withdrawal combined with volatility and 3) the effect of bank competition in a simplified setting.

3 Empirical Framework

3.1 Exogenous Variation in Deposit Volatility

To test our proposition, we need a source of variation that affects banks through a change in only the second moment of deposits and, only through this, changes the equilibrium loan characteristics. For this reason, we focus on a unique natural experiment that takes place in Pakistan every year and is associated with the payment of the Zakat contribution.

3.1.1 Zakat and Deposits

Zakat is a poor-giving religious obligation, the third of the five pillars of Islam. It is formalized in Sharia law, which states that, at the beginning of every Ramadan, individuals must provide to the poorest a donation 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. In 1981 the Pakistani government introduced a mandatory Zakat payment to the state[7] and implemented it through a Sharia-compliant obligation in the form of a 2.5% levy on bank deposits that exceed the Nisab-i-Zakat threshold. This threshold, emanating from Sharia law, is calculated using the international price of silver and corresponds to the value of 52 tolas (612.32 grams). One central characteristic relative to the timing of this obligation plays a pivotal role: the threshold is announced by the State Bank of Pakistan and the Ministry of Religious Affairs only 2–3 days before the collection and management, and the obligation applies on only those deposits held in banks during the first day of Ramadan, for their entire amount and not only the proportion exceeding the threshold.

Despite the good cause, most Pakistanis avoid the levy altogether and prefer to give individual donations.[8] In fact, there is ample anecdotal evidence from newspapers that individuals run 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.[9] Although several

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

[8]In fact, Pakistan has the highest philanthropic contribution in South Asia as a share of GDP. Refer to the work of the Charities Aid Foundation, World Giving Index 2015. While in terms of Zakat revenue classification, the International Monetary Fund (IMF) finds the accounting of Zakat collection in many Muslim countries, including Pakistan, to be challenging (see https://www.imf.org/external/pubs/ft/gfs/manual/compil.pdf). On the interpretation of Zakat, this means to spare from one's net wealth at the prescribed rate by Sharia for sustenance of the poorest who are entitled to be the beneficiary of this obligation (Latif (2012)).

[9]In 2006 the *Dawn* newspaper had the headline "Heavy withdrawal to avoid Zakat cut" (available at http://www.dawn.com/news/211676/heavy-withdrawal-to-avoid-zakat-cut); in 2012 it had the head-

studies exploit the effect of the lunar calendar and seasonal fluctuations relative to Ramadan on a variety of economic variables,[10] in the present research we exploit the specific relationship of the Zakat contribution to the international price of silver. Sharia law directly links the Nisab-i-Zakat threshold to the current price of silver, and in Appendix C we show a scatter plot between the threshold and the international price of silver per ounce in USD on the day of the announcement, which exhibits a correlation of 0.998. In addition, four facts regarding Zakat are particularly useful for our research, because they facilitate our identification. First, Zakat is a mass phenomenon, and the threshold above which Zakat applies is low: the average amount of Nisab-i-Zakat over the 2002–2010 period corresponds to 25,856 Pakistani rupees (PKR), converted approximately into 250 USD. This is particularly low, given that in the same period the average GDP per capita lies at 2,595 USD, the average Pakistani deposit account contains 868 USD and on average 65% of deposit accounts exceed the threshold (see Appendix C). Second, silver price can be taken as exogenously determined to Pakistan, given that this country is among neither the world's top 20 producers nor the world's top 20 consumers of silver and that its first commodity trading platform begun offering silver futures only in mid 2011 (after the period in analysis in this paper).[11] 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 (as widely known in the commodity literature); 2) there is no correlation between the mean price of silver and its volatility at quarter–year level and 3) silver price volatility increases with gold price volatility and declines with the volatility of economic variables (e.g. inflation, Fed funds rate, industrial production). Fourth, because Ramadan is based on a lunar calendar, its first day changes yearly and is progressively anticipated year by year from November 2002 to June 2015, as shown in Appendix C. This permits us to net out seasonality effects.

3.1.2 Zakat, the Price of Silver and Deposit Volatility

Newspaper anecdotes, as mentioned in the previous section, suggest the existence of a withdrawal phenomenon prior to Ramadan and redeposit after the Zakat payment. As a result, this

line "During Ramazan, Pakistanis dodge tax collectors" (available at http://www.dawn.com/news/742885/during-ramazan-pakistanis-dodge-tax-collectors) and in 2013 it had the headline "Clients rush to banks to avoid Zakat deduction" (available at http://www.dawn.com/news/1024075).

[10] In this respect, we use insights from a rich literature that recognizes the effect of the Islamic calendar – essentially based on the lunar cycle – on various aspects of the Pakistan economy. For example, Riazuddin and Khan (2002) pioneer methods to control for Islamic calendar seasonal effects to forecast better the path of currency in circulation. For an extensive review of methods to adjust for the Islamic calendar, refer to Akmal and Abbasi (2010) and Riazuddin (2012).

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

implies only a temporary depletion of the deposit stock in the six months around Zakat. In this section, we complement the previous elements with a statistical analysis to verify whether the following three hypothesis are met in the data:

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

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

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

Unfortunately, we do not have access to high-frequency deposit data at bank-level: the highest available frequency is quarterly, which does not permit to study the rich within-quarter changes in temporary deposits. For this reason, in the interest of higher frequency, we investigate the first two points using aggregate country-level data in Pakistan and use data on the weekly amount of bank deposits and liquidity injections. These are only available for the years 2007-2014 and, therefore, in this section we restrict on this period.

We define a variable, called Zakat 6-months, which takes unit value for the three months before and three months after payment of the Zakat. Table 1 indicates that, although the level of deposits does not change over the whole period, in column (1), banks acquire substantial liquidity injections by the State Bank of Pakistan, which increase by approximately 37%, in column (2). While it is possible that banks adjust also through other margins (e.g. holding more cash), this table shows that the liquidity offered by the central bank in this period is extensively used by banks.

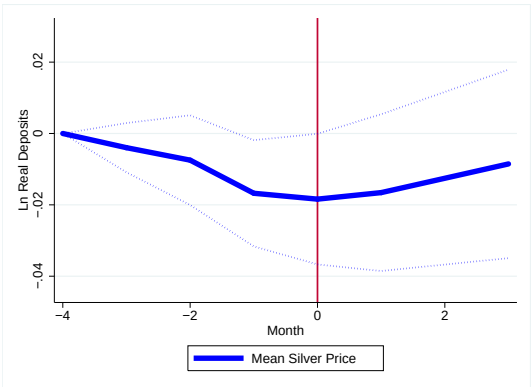
We further dissect the deposit behaviour in the following two ways. First, we show that deposits exhibit a temporary drop of -1.8% in the month of the payment of Zakat in column (3) of Table 1. Furthermore, column (4) highlights that this drop is lower when the price of silver is higher, a one standard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

Table 1: Deposits, Liquidity and Zakat

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

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

Figure 3: Deposit Withdrawal and the Price of Silver



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

Table 2: Deposit Volatility, Zakat and Silver

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

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

It is important to discuss the extent of the deposit drop. A 2.5% levy on a stock, such as deposits, should have been expected to generate much larger deposit-and-withdrawals. From anecdotal evidence, and Figure 3, we may infer the effect being mostly inframarginal, with a large number of relatively middle-income customers activating this phenomenon through small withdrawals. To put things into perspective, in Appendix D we report data on the evolution of Zakat proceedings over time and find that Zakat collections are sizeable, comparable to 0.4% of Pakistan's tax revenues. Zakat can be considered as a special case in which there emerges policy-induced uncertainty in deposit withdrawal, which recalls the work of Bloom (2009).

Finally we focus on the volatility of bank deposits and show that the volatility in the price of silver has an effect on the volatility of bank deposits in the period preceding Zakat. In order to calculate a variable describing deposit volatility, we go from a weekly analysis on the level, to a monthly analysis on the second moment. We calculate deposit volatility by detrending the real deposit series, calculating the standard deviation of the detrended deposits over a month and dividing by the mean level of deposits in the corresponding month. This results in the coefficient of variation of deposits, which can be interpreted as the fluctuations in deposits as percentages of the mean.

We define a new dummy, Zakat 3-months, which takes unit value only for those three months. This is regressed over the volatility of bank deposits, including interactions both with silver price volatility and mean. Table 2 shows that during the three months before Zakat there is a general increase in volatility, by around half a standard deviation, and in particular this grows in the interaction between the Zakat dummy and silver price volatility: a one standard deviation increase in silver price volatility, during the three months before Zakat, generates an additional half standard deviation increase in deposit volatility. On the contrary, we do not find a significant effect for just the level of silver volatility outside Zakat or the level of silver in general.

Overall, this section shows that the Zakat period exhibits a special deposit behaviour, with a temporary drop in deposits, a high usage of central bank liquidity and a deposit volatility increasing in silver price volatility. All these features are key for our identification, which we describe in detail in the next section.

3.2 Identification

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

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

2. the cross-sectional variation in bank exposure to Zakat, describing in detail the extensive and intensive margins of Zakat.

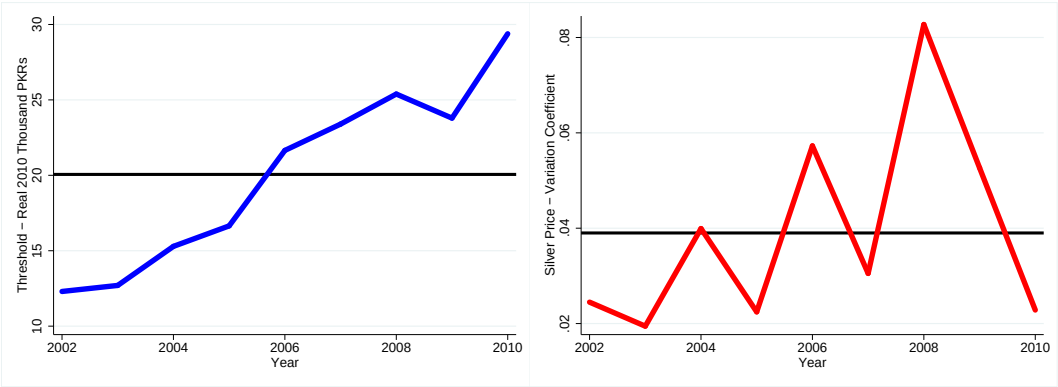
3.2.1 Time-Series Variation

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. In the case of low deposit volatility, banks can observe the average price of silver and can predict with precision the decline in deposits associated with Zakat. If the price of silver is stable, then the range of values that the deposit drop can take is bound in a relatively tight interval. As a result, banks can adjust their management of cash and other liabilities to smooth out the deposit drop completely in anticipation of the drop. However, if the price is volatile, such adjustment is imperfect, and therefore banks face a higher-than-expected risk of needing to borrow at expensive rates because of sudden swings in the international price of silver. Consequently, they insure themselves by passing onto borrowers the expected cost of the alternative liquidity, which generates a decline in long-term maturities.

Figure 4 reports both the announced threshold (left panel) and the volatility in silver price in the quarter before the announcement (right panel), and this last element shows that on average the volatility is relatively high, as fluctuations average 4% of the mean price in the quarter before Zakat, in a range between 2% and 8%. As discussed in Appendix C and D, silver price is highly volatile (more than gold, oil and copper), mainly because it is traded mostly for industrial use rather than store of value. As a result, the spikes in Figure 4 are mostly due to

low-liquidity on international markets or periods of volatile silver demand. The sudden swings in this variable generate useful variation for our identification.

Figure 4: Nisab-i-Zakat Threshold and Silver Volatility - 2002-2010



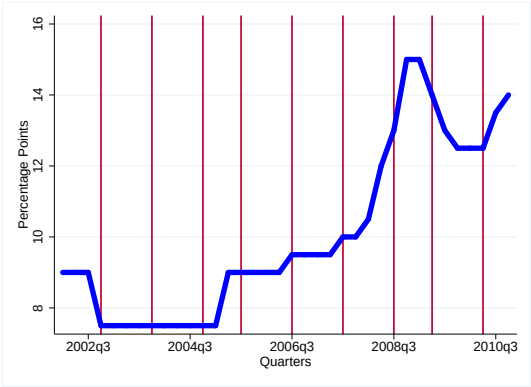
Notes: This figure reports the the real value of the Nisab-i-Zakat threshold in 2010 real Pakistani rupees (PKR) on the left panel (in blue) and the volatility in silver price in the quarter before the threshold announcement on the right panel (red) between 2002 and 2010. Silver price volatility is defined as the coefficient of variation defined by 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 threshold lies at approximately 250 USD. 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.

Discount Rate and State Bank of Pakistan Replacing deposits with central bank liquidity can be expensive in Pakistan. As shown in Figure 5, the average discount rate between 2002 and 2010 (years in analysis) was roughly 10% and fluctuated between 7.5% and 15%. This generated a 5% average premium on liquidity, between 2.5 and 10 points above the deposit rate (5%, shown in Appendix R). The State Bank of Pakistan, as the local central bank, is responsible for the conduct of the monetary policy and defines the discount rate through its policy meetings, which in general take place at quarterly frequency. As highlighted by our model, this is a key variable because in combination with deposit volatility, it changes the intertemporal allocation of lending by commercial banks. As previously reported, there is ample evidence showing that the State Bank of Pakistan intervenes strongly to support banks' liquidity during Zakat. This is generally 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. Second, we cannot reject the null hypothesis of not discount rate adjustment during the Zakat period.

In this respect, Figure 5 shows the evolution of the discount rate over the sample period, between the first quarter of 2002 and the fourth quarter of 2010 and reports a vertical line for the quarter that includes Zakat. Over this interval, the policy rate showed some non-negligible fluctuations, with an average rate of 10%, a standard deviation of 2.4 points, a minimum of 7.5 and a maximum of 15. The moderate increase in rates coincided with the global crisis in food price inflation. It is difficult to verify the presence of a policy rate response to Zakat, and in Appendix E, Table E1, we regress the discount rate (that varies at quarter-year level) over a Zakat quarter dummy and cannot reject the null hypothesis of no rate change, even accounting

for quarter or year fixed effects. Note that as Zakat changes quarters over time, due to the lunar calendar, we can control for seasonality and other recurring factors. The Zakat coefficient is not only insignificantly different from zero but also very small in magnitude.

Figure 5: Discount Rate and Zakat



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

Among several reasons behind this lack of rate adjustment, it could be possible that the State Bank of Pakistan is facing a classical Tinbergen rule problem (Tinbergen (1952)). If the central bank stakes its credibility on a given target (inflation, fiscal deficit, output gap, exchange rate) and uses the policy rate to address such a target, then it may have relatively few options to intervene toward a relatively secondary objective such as the neutralization of deposit volatility during Zakat. This seems to be a likely scenario because analysis of the Monetary Policy Decision statements of the State Bank of Pakistan between 2002 and 2010,[12] finds that there is generally no direct reference to the liquidity pressures generated by Zakat or the Ramadan period.

In only one period, September 2009, is Zakat explicitly mentioned:[13]

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

It is particularly interesting to analyse this statement for two reasons. First, there is explicit recognition of the liquidity tightness as Ramadan approaches and the Zakat payment becomes 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

[12] Available at http://www.sbp.org.pk/m_policy/mon.asp

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

to be considered in its setting: inflation, output gap, fiscal consolidation, supply constraints (electricity) and foreign inflows. These are useful because they all point toward a multitude of objectives to be covered and, possibly, insufficient instruments to address them all.

3.2.2 Cross-Sectional Variation

The extent to which the Zakat contribution affects banks depends on a few key components that can support our identification. In this paper we focus on two:

1. The extensive margin of Zakat: as measured by the share of ATMs in Sunni-majority areas by each bank (ATM exposure).

2. The intensive margin of Zakat: as measured by the gap between the average bank deposits and the Nisab-i-Zakat (deposit exposure).

The Extensive Margin of Zakat Pakistan is an Islamic republic, with 95% of its population professing Muslim faith and the remainder composed mostly of Christians, Hindus, Buddhists and Animists.[14] The majority of Muslim Pakistanis adhere to the Sunni school (76%), with the remaining 19% belonging to the Shia.[15]

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,[16] whereas Shia Pakistanis have been allowed to contribute their Zakat individually since the mid 1980s.[17] 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 geographic network of all ATMs by all Pakistani banks between 2002 and 2010, by describing the number of branches per city by every bank in

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

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

[16]The 1980 ordinance allows individuals of any *fiqh* (sub-practice within the Sunni and Shia traditions) to fill an exemption module. In principle, it would be possible also for Sunni Pakistanis to seek a Zakat exemption. However, this is rare, in some cases because of social stigma and lack of transparency from some banks. As *Dawn* reports: "[Sunni] Account-holders may also submit an affidavit seeking exemption from Zakat deduction. However, bankers said most people did not opt for this option. They used to withdraw their money before Ramazan and deposit them after first Ramazan" (available at http://www.dawn.com/news/647723/zakat-exemption-limit-doubled).

[17]This exemption was discussed between 1982 and 1988 and implemented in the final correction of the law in 1989. It relies on a different interpretation of the Zakat between the Sunni and Shia schools of Islam; Nasr (2004) provide fascinating historical and political accounts of these discussions. Regarding the norm of the original Zakat law, which was established in 1981 and amended in 1989, Chapter III, Section 20 of the law declares "Zakat not to be deducted in respect of the assets of a person claiming exemption on grounds of faith and *fiqh*" (this original ordinance is available at http://www.zakat.gop.pk/system/files/zakatcollectonrefund1981.pdf). Specifically, Shia Pakistanis are mostly part of the *Jaffaria Fiqh*, although other *fiqh*s do co-exist in the Shia school of Islam.

each year. This map has been superimposed onto the religious map of Pakistan produced by Dr M. Izady and the Columbia University Gulf/2000 project.[18] 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, we exploit only the cross-sectional variation of this index, because the time-series change in this indicator is negligible (as shown in Appendix D). For this reason, rather than using a bank–year-level index, we take a bank average of this exposure over 2002–2014 and define it as $Exposure_b$. We refer to this exposure indicator as the extensive margin of Zakat because this leads to a comparison between banks that have more individuals running to the bank and banks that have fewer such individuals (but there is no content on the amounts of the withdrawals). This indicator has a mean of 0.415 and a median of 0.5, with a standard deviation of 0.207.

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

For this reason, we exploit a feature of the Monetary Survey of Pakistani banks, collected by the State Bank of Pakistan, which requests all banks to state the amount contained in their average deposit account, and we define the following index of exposure $Exposure_{by} = {Avg.Deposit_{by}}/{Nisab-i-Zakat_y}$, in which the exposure of bank b to Zakat in year y is higher when the average amount deposited relative to the Nisab-i-Zakat threshold in year y is higher. Therefore, for a given year y and threshold, banks with a higher deposit amount are modelled to be more exposed to this phenomenon. Conversely, for a bank with a given amount of average deposits, the higher the Nisab-i-Zakat, the lower its exposure. 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

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

phenomenon. A further disadvantage is its availability, because it was measured between only 2005 and 2009. We refer to this exposure indicator as the intensive margin of Zakat because this leads to a comparison between banks with customers who withdraw more and banks with customers who withdraw less (but there is no content on the number of people running). This indicator has a mean of 4.24 and a median of 1.16, with a standard deviation of 6.54.

3.3 Empirical Model

Our theoretical proposition embodies the key contribution of this paper and describes how lending conditions and investment decisions are affected by changes in deposit volatility. It is important to note that through our identification we focus on bank-specific time-varying changes in deposit volatility, which we can identify in a reduced-form using the exogenous variation in silver price volatility. There may be other features of deposit volatility that are either constant at bank level or constant for all banks but vary over time, which we cannot study. In fact, the identification of these alternative sources of volatility may correlate with other bank-specific or time-specific features (e.g. profitability, attitude to risk, international exposure to shocks). For this reason, we remove these features through bank, bank-quarter and time fixed effects.

Our proposition shows that the interaction between deposit volatility and the discount rate generates

1. changes in loan characteristics: more deposit volatility in presence of a high discount rate leads to a shortening of average maturities, a decline in lending rates and no impact on the average size of a loan

2. changes in investment profile: in response to higher long-term lending rates, firms switch from long-term investment to short-term investment.

3.3.1 Loan Characteristics

In our identification, 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 through the extensive and intensive margins. Therefore we model Zakat as $Zakat_{bt} = Exposure_b \times Silver\,\sigma_t$, in which $Exposure_b$ measures the exposure of bank b to Zakat, which depends on the margin, and $Silver\,\sigma_t$ is the variation coefficient of the detrended international silver price during the quarter before the beginning of Ramadan, which is our reduced-form measure of deposit volatility.

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

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

Such characteristics are regressed over the Zakat variable and its interaction with the discount rate at which the State Bank of Pakistan prices liquidity to banks at time t, $Rate_t$. The time dimension, denoted by t, is the quarter of a year. Therefore, controls are included at the level of bank for every quarter of every year, X_{1bt}. Given that the variation we explore is bank–time-varying, bank-level characteristics are the most important to introduce in this setting. Specifically, we control for: 1) the capital-to-asset ratio, as a measure of risk taking; 2) the return on asset, after tax, as a measure of bank profitability; 3) the ratio of government securities to total assets, to account for exposure to the Pakistani government and their possible liquidity effect; 4) the deposit share of liabilities, to measure the degree of reliance on deposit as a source of funding, and 5) the natural logarithm of the total assets in real PKR, as a measure of bank size.

We also include a variety of fixed effects: 1) at bank and firm level to remove bank and firm fixed 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); 4) a bank–quarter fixed effect to remove seasonality on the conditions of loans offered by bank b in quarter q and 5) a fixed effect for every quarter of every year to remove common shocks.

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.

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. For simplicity, in this experiment we can assume three extreme cases: 1) the existence of a bank exposed to Zakat, indicated by Treatment and B_T, and not exposed to Zakat, indicated by Control and B_C; 2) the presence of two values of silver price volatility, high, σ_H, and low, σ_L, which can be thought of as zero and 3) the presence of two values of the discount rate, high, r_H, and low, r_L, which can be thought of as zero. As described by the theoretical model, the experiment takes place only when there is high silver price volatility combined with a high discount rate. Therefore all cases with a low discount rate, r_L, can be considered as cases with no experiment taking place: the "before" period, with loan characteristic Y_{0T} for the treated bank and Y_{0C} for the control bank. Conversely, the experiment switches on when both volatility is high and the discount rate is high: the "after" period, with loan characteristic Y_{1T} for the treated bank and Y_{1C} for the control bank. Therefore the first difference, $Y_{0T} - Y_{0C}$, describes the difference in loan characteristics between the two banks, which can be considered due to structural unobservable bank–borrower specific parameters; the second difference, $Y_{1T} - Y_{1C}$, describes how these characteristics change in presence of volatility during a high policy rate. Finally, the difference between these two differences describes how the exposed bank changes its loan characteristics

during periods of high volatility and high policy rate compared with the non-exposed bank, netting out the structural differences caught during low rate periods.

To simplify the interpretation of the coefficients in equation (1), we standardize the two main regressors ($Exposure_b$, $Silver\sigma_{ty}$), subtract from the discount rate its minimum value and divide by the standard deviation. As a result, β_1 can be interpreted as the change in the characteristic x_{bft} of a loan received by firm f from bank b in response to a one standard deviation increase in silver price volatility for a bank one standard deviation more exposed to Zakat, given that the discount rate is at its minimum value (7.5% in our sample). Correspondingly, β_2 adds to this the role of a one standard deviation increase in the discount rate.

Given that our treatment varies at bank–quarter–year level, we allow the residual of loan characteristics to be correlated within banks and quarter–year. For this reason, we cluster our standard errors for every bank in every quarter of every year to account for within-cluster heteroskedasticity; however, in the robustness section (Section 4.3) we run a variety of other tests to account for a variety of alternatives.

3.3.2 Investment Profile

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

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

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

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

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

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

Note that this exercise, although being tied to the theoretical model, is not the ideal experiment. To perform the ideal exercise, we would need data about each single investment project

considered by each firm at any point in time, which should be linked to the loan characteristics received, so that we could: 1) disentangle investment demand from finance supply and 2) verify that when financial products present worse conditions for the long term, firms either reduce or abandon long-term projects. The view offered in this section, and Table 4 in Section 4.2.3, is the best we can offer and results in a relatively more aggregate picture, which although imperfect is analogous to the ideal experiment.

4 Data and Results

4.1 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.[19] 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 has been made available for years 2002–2010.

2. Pakistan ATM Bank-Wise Network and information on $Exposure_b$. This document maps for every bank operating in Pakistan in every year the ATM location in each city, and sub-city address for the largest cities. This information is collected by the State Bank of Pakistan in its annual statistical publication.[20] 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, Figure D2, 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.

[19] Until April 2006, the State Bank of Pakistan restricted the reporting to loan amounts above 500,000 PKR (corresponding to 4,807 USD); after this date all loans enter the dataset.

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

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.

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 firms in 15 sectors between 2005 and 2010. We are able to match this database with the loan-level data from banks and verify the investment profile predictions of the proposition. This test is likely to deliver a lower-bound on the investment effects of Zakat because these are large firms with several bank connections and access to alternative financing (both bond and stock).

4.1.1 Sample from the Credit Information Bureau Data

The Corporate Credit Information Report contains information on more than three million loans between 2002 and 2010 given to over 90,000 borrowers. Unfortunately, because of the inappropriate entry of some information by financial institutions, not all of these loans are available for our analysis. Specifically, we restrict our sample to those loans with no missing values or spelling mistakes for the loan maturity, the lending rate and the amount of the loan. This leads to a sample of 1,060,137 loans over the nine years 2002–2010 from 30 banks to 24,972 firms.[21]

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 section 4.3 we discuss the issue of sample selection and verify that the probability of belonging to our sample is uncorrelated with the Zakat variables. On average a firm receives 42.5 loans over the whole period and 4.7 loans per year. Several firms borrow from multiple banks, with 14.57% of all loans originated by a firm that borrows from at least two banks in the same quarter of the same year.

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

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 - The Extensive and Intensive Margin of Zakat					
Extensive Margin	30	0.41	0.20	0	0.54
Intensive Margin	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	0.01	15.511

Notes: This table reports the number of observations, mean, standard deviation, minimum and maximum values for the main variables in this analysis from the most important databases. Panel A shows information from the Corporate Credit Information Report on: the maturity of loans in the natural logarithm of days (the mean corresponds to 578 days), the lending rate and the amount of the real loan in the natural logarithm of 2010 PKR. Panel B shows information on the bank exposures to Zakat as defined in Section 3.3.1. The extensive margin of Zakat summarizes the share of ATMs held in Sunni-majority areas. ATM exposure is used because the largest banks, which are involved in the most important cash transactions, have at least one ATM. The second index of exposure is given by intensive margin of Zakat, measured as the ratio between the average deposit of a bank and the Nisab-i-Zakat. Panel C shows summary statistics for the discount rate, as defined by the quarterly meeting of the Pakistan central bank and silver price. The first row reports the coefficient of variation of silver and the mean of silver and the unit of observation is the quarter of a year. The coefficient of variation is calculated by dividing the standard deviation of the detrended silver price at quarter-year level by the average silver price in the same quarter-year cell. Panel D shows summary statistics from the monetary surveys, reporting bank-level variables on the 30 banks analysed for every quarter of every of the nine years between 2002 and 2010. Capital to assets measures the ratio between the bank equity and size of the balance sheet, ROA is the after-tax return on assets, GVT Bonds to Assets is the exposure to government bonds through a ratio of the federal government securities holding over total assets, Deposit to Liabilities is the share of liabilities funded through deposits and Total Assets is the size of a bank's balance sheet. Panel E reports the summary statistics on the outcome variables and the sales variable for 237 firms belonging to the sample. Total investment is defined as the growth rate in firm assets net of depreciation, fixed investment as the growth rate in fixed assets net of depreciation and working capital as the growth rate in working capital. The sales variable is expressed through the natural logarithm of its real 2010 thousand PKR value.

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 extensive margin of Zakat, through the share of ATM in Sunni-majority areas, which is time invariant and hence we have only one

observation per bank, and 2) the intensive margin of Zakat, through the deposit exposure, which varies per bank over time and we observe it for six years, which provides 175 data points. Panel C reports time-series information on the variables used in our estimation: the discount rate and silver prices, reporting summary statistics both over its volatility and mean price. Both of these variables vary at quarter-year level. Panel D reports the summary statistics for the bank-level controls. Finally, Panel E reports summary statistics on the outcome for the firm-level analysis (total investment, fixed assets and working capital), with all these variables defined as the growth in firm assets (respectively, total, fixed and working capital) net of depreciation. The sales variable expresses the size of these firms: these are big firms, with average sales of 121 million USD, with large cross-sectional heterogeneity. For example, oil and mining companies are among the largest firms (e.g. Pakistan State Oil Company and Shell Pakistan).

4.2 Main Results

4.2.1 Loan Characteristics

The main results of this section are listed in panels A and B of Table 4, which differ only by the analysed margin of Zakat: the extensive margin (ATM exposure) in Panel A, and the intensive margin (deposit exposure) in Panel B. In both panels, the first three columns report results that include only the Zakat variable and, in the next three columns, its interaction with the discount rate: in all cases we introduce controls varying at bank–time level. In Table 4, we do not observe evidence of a significant effect of the Zakat variable *per se*. In fact, all coefficients in the row $Zakat_{bt}$ are not statistically different from zero and are small in magnitude. Most of the action originates from the interaction with the discount rate. In Table 4, column (4), banks that are one standard deviation more exposed to Zakat, in presence of a one standard deviation higher silver volatility and discount rate, present loans with maturities shorter by 2% (approximately 12 days). Column (5) shows that even at the lowest level of the discount rate, there occurs an increase in the lending rate by almost 0.3 points, but this declines by 0.13 points for every standard deviation increase in the discount rate.

This is consistent with our hypothesis to the extent to which borrowers are willing to tolerate a slight increase in the long-term lending rate in order to receive a long-term loan; but when such increase grows (as the discount rate rises) then they move progressively to a lower maturity and, correspondingly, lower lending rate products. Last but not least, in column (6) there emerges no change in the amounts of loans. Panel B confirms qualitatively these results, with however much larger magnitudes: the decline in maturities is 14.4% (corresponding to 83 days), the increase in the lending rate in the minimum policy rate is 0.7 points and declines by roughly 0.7 points for every standard deviation increase in the policy rate, and also in this case loan amounts do not respond.

Table 4: Zakat and Loan Characteristics - Bank Controls

Variables	(1) Maturity Ln(Days)	(2) Lending Rate	(3) Loan Ln(PKRs)	(4) Maturity Ln(Days)	(5) Lending Rate	(6) Loan Ln(PKRs)
Panel A - Extensive Margin						
$Zakat_{bt}$	-0.0100	0.0363	-0.0124	0.0343	0.296**	-0.00878
	(0.00665)	(0.0370)	(0.0122)	(0.0220)	(0.121)	(0.0273)
$Zakat_{bt} \times Rate_t$				-0.0226**	-0.132**	-0.00182
				(0.0106)	(0.0518)	(0.0131)
Observations	1,060,137	1,060,137	1,060,137	1,060,137	1,060,137	1,060,137
Adj. R sq.	0.784	0.708	0.889	0.784	0.708	0.889
Panel B - Intensive Margin						
$Zakat_{bt}$	-0.0439	0.0651	-0.157	0.0906	0.711**	-0.138
	(0.0356)	(0.135)	(0.114)	(0.0690)	(0.305)	(0.243)
$Zakat_{bt} \times Rate_t$				-0.144**	-0.692**	-0.0206
				(0.0556)	(0.313)	(0.185)
Observations	662,744	662,744	662,744	662,744	662,744	662,744
Adj. R sq.	0.734	0.688	0.890	0.734	0.688	0.890
FE b, bf, bq, ft	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 firm, firm–year, bank–firm, bank–quarter and quarter–year, as reported in the third-last row FE. Standard errors are clustered at bank–time level; the number of clusters is 816 in Panel A and 383 in Panel B. Maturity in Days Ln measures the maturity of a loan through the natural logarithm of its number of days between the origination of the loan and the contracted end date. Lending Rate reports the interest rate applied by the bank to the firm on the loan. Real Loan Amount Ln measures the natural logarithm of the amount of the loan in real 2010 PKR. These variables are regressed on the following: 1) $Zakat_{bt}$ is a variable composed by the interaction of the standardized exposure of bank b and the standardized variation coefficient of silver price in the three months preceding the first day of Ramadan; 2) the interaction between $Zakat_{bt}$ and $Rate_t$, multiplies the $Zakat_{bt}$ variable with the discount rate as applied by the central bank on liquidity loans to private banks. Such policy rate is modified as follows: we subtract the minimum value, 7.5%, and divide by the standard deviation 2.43%. In this way, the coefficient on $Zakat_{bt}$ can be interpreted as the effect of a one standard deviation increase in silver price volatility for banks that are one standard deviation more exposed to Zakat, in the minimum rate (7.5%). The interaction can be interpreted as the additional effect on the previous effect of a one standard deviation increase in the discount rate. Panel A reports the extensive margin of Zakat using the standardized share of branches in Sunni-majority cities. Panel B reports the intensive margin of Zakat using the standardized ratio between the average deposit account for bank b divided by the wealth threshold, Nisab-i-Zakat, for the year. The bank-level controls reported here vary at the t level and are the Capital to Assets ratio, the ROA (return on assets), the government bonds to total assets ratio, the deposit share of liabilities, and the natural logarithm of total real assets. The number of Observations and Adjusted R^2 (Adj. R sq.) of each regression is reported in each panel. For the extensive margin of Zakat, we can use the full sample with 1,060,137; for the intensive margin, 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 panels deliver conceptually similar results, with large quantitative differences. This is due to a Local Average Treatment Effect, LATE, interpretation, given the different margins exploited by each identification. In fact, Panel A embodies the role of the extensive margin of Zakat and compares banks heterogeneously exposed to Sunni versus non-Sunni. Conversely, Panel B measures the intensive margin by providing a measure of the bunching around the Nisab-i-Zakat threshold. Given the nature of the Zakat phenomenon, it is plausible to expect

the intensive margin to be larger than the extensive margin, considering that 76% of Pakistanis belong to the Sunni branch and are subject to the Zakat regulation: in the extensive margin we cannot distinguish between compliers and non-compliers, while in the extensive margin we have a more refined measure of compliers.

Both identifications 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 report the evolution of the elasticity of loan maturities, lending rates and loan amounts to the discount rate. Figure F1 reports these for the extensive margin of Zakat, Figure F2 reports these for the intensive margin of Zakat and both report the linear predictions of the effect, as emerging from Table 4. In Figures G1 and G2, it is also possible to find the same picture, in which we introduce a dummy for every quartile of the discount rate. 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 presence of a high discount rate, with the rate ranging between 12% and 15% (recorded during 25% of the sample). For lower values of this rate, the magnitudes tend to decline monotonically to zero and are often not statistically different from zero.

A variety of concerns could affect our estimates, and in the appendices we offer a series of tests to accommodate possible concerns. 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-level *per se* and interacted with the discount rate; and finally introducing loan-level, bank-level and interactions with the discount rate. This does not affect our results. Second, the Zakat payment can have both an effect on banks uncertainty over a very high deposit withdrawal (the core of this paper), but also through the temporary decline in deposits (level effect). We address this in the following three ways: first, we always control for the level of deposits measured at quarterly frequency in the regressions (normalized by the share of assets); second, we take care of the expected deposit decline using bank-quarter fixed effects and third, in Appendix I, we add to the main specifications a control for the interaction between the exposure to Zakat and the mean price of silver in the three months before Zakat and their interaction with the discount rate. As shown in Tables 1 and 2, because the first moment of silver has an effect on the first moment of deposits, while the second moment of silver has an effect on the second moment of deposits, we can use our reduced-form also to account for the level effect. Third, because it may be argued that silver price volatility could correlate with a variety of macroeconomic factors, in Appendix J we replicate the results of Table 4 and add to the main specification an alternative in which we multiply the bank exposures to Zakat (and also its term with the discount rate) with the following macroeconomic controls: 1) GDP per capita; 2) GDP per capita growth; 3) Inflation; 4) Exchange Rate; 5) Foreign Direct Investment capital inflows (FDI) and 6) all the previous controls together. Although some changes in the point estimates are observed, the results are qualitatively unchanged. Fourth, our sample includes the recent financial crisis, during which global assets and commodities

experienced important fluctuations. In Appendix K, we replicate the results of Table 4 by excluding the months from December 2007 to June 2009, described as recession months by the Business Cycle Dating Committee of the National Bureau of Economic Research. Because this period generated extensive fluctuations in global stocks, bonds and commodities, we show that our results do not rely exclusively on this phenomenon. Fifth, in Appendix L we discuss the results of Bertrand et al. (2004) and Cameron et al. (2012) within our empirical framework and offer a variety of alternative computations of our standard errors; although in some cases some results become significant around 10%, the main findings are unaffected. Sixth, in Appendix M we replicate the results of Table 4 by adopting two alternative measures of silver price volatility: 1) we define volatility as the standard deviation of the daily growth rate in silver price during the quarter before Zakat and 2) we derive measures of expected silver price volatility from option prices, using the Black–Scholes model, for the quarter before Zakat. Despite the alternative methods of calculating volatility, the results are in line with Table 4, given that these measures are highly correlated as shown in Table M1. Seventh, in Appendix N we extend our results to a two-month window and a four-month window, showing that our findings are mostly unaffected. Eighth, as clarified in Section 4.1, we extract from the universe of Pakistani corporate lending (roughly three million loans) a sub-sample containing loans that record a maturity in days, a lending rate and a size in PKR. Because of reporting mistakes by banks, some loans are unable to be used: from missing one or more key variables, to reporting no borrower or bank code, to obvious typing errors (i.e. maturities with missing or invalid numbers). In Appendix O we show that this measurement error is uncorrelated with our Zakat variables: this is achieved by regressing a dummy variable taking unit value when a loan is included in our sample and zero otherwise on the Zakat variables. We find that the probability of belonging to the sample does not correlate with Zakat. In Appendix P we replicate Table 4 without firm-time fixed effects, in order to broaden the scope of the analysis from within-firm-bank across-banks to a within-bank and within-firm. These regressions show that even in this context with a less clear identification, the main results still apply, with smaller magnitudes observed for the extensive margin case. Finally, in Appendix Q we offer some further test showing that the results of the bank maturity channel are heterogeneous across different firms. In Table Q1 we show that firms with a larger lending volume tend to be less affected, though the magnitudes are quite small: only firms that are between 5 and 10 standard deviations above the mean are immune to volatility. On the contrary we see that firms taking more loans, but not necessarily larger loans, are not differentially affected. In Table Q2, we show that firms with a higher share of collateralization are comparatively less affected, but once again with small magnitudes; while the presence of a rating does not heterogeneously affect the results.

4.2.2 Additional Evidence

In this section we provide evidence on three additional predictions of the model. First, we explore the reaction of the *agreed* lending rates at different maturities in presence of deposit volatility and a high discount rate. We verify that the lending rates on longer-term loans (with a maturity exceeding 4 and 5 years) increase more than those with a short maturity and the

share of such loans declines in presence of higher volatility and cost of liquidity. Second, we show that also among loans with short-maturities (less than one year), there is a reallocation toward loans with a maturity of three months or less and loans that are given and repaid before Zakat. Third, consistently with the model, we cannot reject a positive, yet imprecise, effect of Zakat on deposit rates.

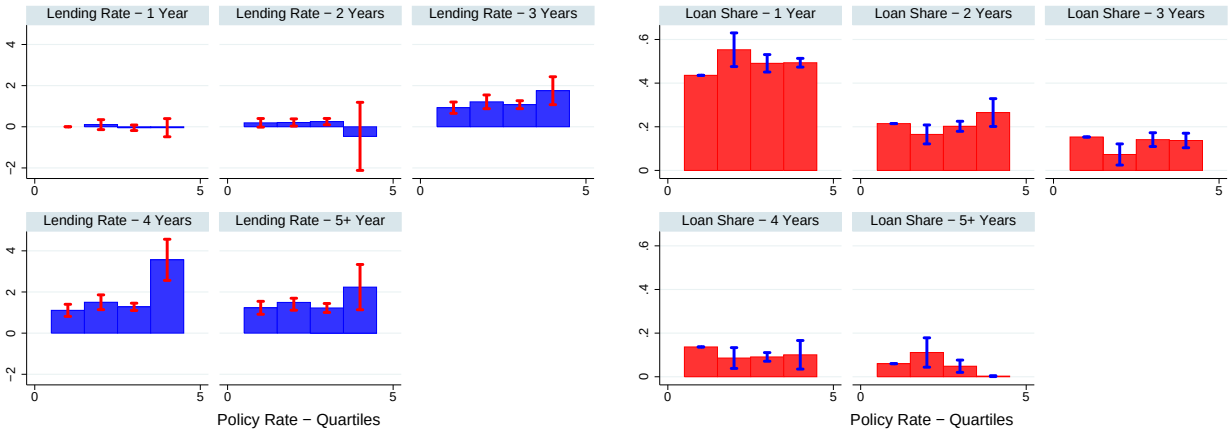
For the first point, we present two tests:

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

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

Given the more descriptive evidence of this section and the fact that the intensive margin of Zakat gave larger magnitudes, we temporarily focus on only these two exercises, which are presented in Figure 6. In this way, we can verify the extent to which lending rates change at each maturity, for each quartile of the discount rate. However, in the quantification exercise presented in Section 5, we use results also from the extensive margin.

Figure 6: Zakat, Lending Rate and Loan Shares



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

Figure 6 shows that the lending rates of loans with a maturity of one year or less and two years do not respond to an increase in deposit volatility and bank exposure for any value of the discount rate, which is in line with our theoretical model. However, the lending rates of loans with a maturity of three, four, or five years or more all increase by around 2.5 points in presence of a one standard deviation in silver price volatility and bank exposure to Zakat. Nonetheless, such increases are registered for a discount rate only in the fourth quartile, which corresponds to a rate between 13 and 15 percentage points. The lower panel of Figure 6 reports a similar

exercise, in which we aggregate the loans at bank–quarter level to verify how the distribution of disbursed loans reacts to changes in deposit volatility and discount rate. Analogously to the previous picture, we can see two key results: 1) at the fourth quartile of the discount rate there is a disappearance of loans with a maturity of five years or more and 2) there is a corresponding increase in loans given at maturity of one year or less and two years. Therefore, this bank-level characteristic confirms our findings. This is not a fully comprehensive test: in this section we can see how *agreed* long-term rates respond to deposit volatility and a high discount rate and we are aware that selection could take place in either direction. However, we believe that these results and those in Section 4.2.1 are consistent with the bank maturity channel.

Table 5: Zakat and Short-Term Loans

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

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

Second, we verify the behaviour of very short-term loans by looking at the changes of maturities for loans that are shorter than one year. For this reason two variables are defined: "Maturity 3 Months or Less" takes unit value if a loan has a maturity of less than 90 days and "Loan Given and Repaid before Zakat" taking unit value if a loan is originated and repaid before

the Zakat period. These are a small fractions of overall loans 3.8% and 0.4% respectively and for this reason we cannot exploit the same level of variation applied in equation (1). Therefore while we still employ the Zakat variation, along the intensive and extensive margins, we only introduce bank, firm and time fixed effects. The results, presented in Table 5 are consistent with the hypothesis of a reallocation of toward very short-term loans. A one standard deviation increase in silver price volatility and monetary policy rate leads banks one standard deviation more exposed to give loans with a maturity of 3 months or less by 0.23%, along the extensive margin, and 4.05%, along the intensive margin. Finally, there occurs also an increase in the probability of loans given and repaid before Zakat: a one standard deviation increase in silver volatility, leads more exposed banks to increase the probability of giving such short loans by 0.42% under the extensive margin and 0.62% under the intensive margin. These effects are increasing when the discount rate increases, but are not precisely estimated.

Finally, in Appendix R we show through a time-series analysis of the average monthly deposit rate in Pakistan, that during Zakat there seems to be positive effect on deposit rate, as predicted by the theoretical model and highlighted in Appendix A. Though the point estimate is positive, we are unable to reject an hypothesis that this change is not statistically different from zero.

4.2.3 Investment Profile

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

The results in Table 6 are in line with this prediction. In both columns (1) to (3) and (4) to (6) of Table 6, in presence of Zakat and a high discount rate, there appears to be a redirection of investment from fixed capital assets to working capital, with no overall change in the level of investment. Because of the small extent of Zakat as caught by the extensive margin, the results of columns (1) to (3) are qualitatively in line with the predictions, but too small to be precisely estimated. Conversely, because the intensive margin of Zakat generates larger effects on maturities and rates, we can verify that there is such a redirection of investment from fixed capital to working capital, in columns (4) to (6). The magnitudes are generally small, with a one standard deviation increase in silver price volatility and discount rate leading to a decline in capital assets growth of 0.08 points for firms with a one standard deviation higher bank exposure (19% of a standard deviation) and to an increase in working capital of 0.11 points (19% of a standard deviation). Appendix S reports two additional specifications of Table 6: 1) excluding all firm-level controls and 2) including both firm and bank-level controls. Finally in Appendix T we include the lagged Zakat variables to account for mean reversion and find no

evidence of firms reverting to a higher fixed asset investment after a higher of low fixed asset investment.

Table 6: Zakat and Firm Investment - Firm Controls

Variables	(1) Fixed Assets	(2) Working Capital	(3) Total Investment	(4) Fixed Assets	(5) Working Capital	(6) Total Investment
$Zakat_{ft}$	0.010	-0.004	0.001	0.020	-0.082	-0.037
	(0.015)	(0.013)	(0.007)	(0.077)	(0.105)	(0.068)
$Zakat_{ft} \times Rate_t$	-0.020	0.015	-0.006	-0.085**	0.111*	0.012
	(0.040)	(0.049)	(0.023)	(0.040)	(0.063)	(0.039)
Effect in S.D.				19.1%	19.2%	
Margin	Extensive	Extensive	Extensive	Intensive	Intensive	Intensive
Observations	642	642	642	642	642	642
Adj. R sq.	0.211	0.076	0.211	0.214	0.0764	0.166
FE f, fs, sy, b, bs, by	Yes	Yes	Yes	Yes	Yes	Yes
Mean Dep. Var.	0.002	-0.042	-0.013	0.002	-0.042	-0.013
S.D. Dep. Var.	0.245	0.285	0.189	0.245	0.285	0.189

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

4.3 Identifying Assumption and Robustness

Our identifying assumption relies on the interaction between silver price volatility and the discount rate affecting the loan choice between long- and short-term only through the reaction in their corresponding rates. However, there could be a variety of alternative hypotheses that may provide observationally equivalent results to those in Table 4 and Table 6. For example, the volatility in silver price may independently affect Pakistani banks regardless of the Zakat payment. Local banks may be exposed to a specific asset that reacts to silver price volatility (or commodity volatility in general), with such exposure correlated with the exposure of depositors. Alternatively, banks may anticipate periods of uncertainty and best respond by strategically redirecting selected customers across periods, which would alter the pool of loan applications

in each period. Analogously, the increase in long-term lending rates may change the quality of loan applications and lead banks to alter their lending standards when responding to a lack of liquidity. A different channel may cause the interaction between volatility and rate to affect the borrower equilibrium lending across banks, rather than within-bank across-maturities. In this section, we explore the robustness of our identifying assumption to each of the previous alternative hypotheses, by explaining the challenge, and point to the relevant appendix detailing each test.

4.3.1 Placebo – Eid Adha Celebrations

It may be argued that silver price volatility has an impact on local banks regardless of the bank maturity channel: it could affect a specific asset to which Pakistani banks' exposure correlates with their depositors' exposure. As a result, any exercise exploiting silver price volatility would result in effects analogous to those found in Table 4 and Table 6.

To address this claim, we offer a placebo test to show that the interaction between silver price volatility and the discount rate affects loan characteristics only around Zakat time and that the risk of deposit withdrawal is the driver behind our results. For this purpose we replicate the same exercise as before, but 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) because his sacrifice was accepted. 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,[22] and consumption of meat and other goods.[23]

The most relevant factors behind this placebo are: 1) there are large deposit withdrawals (1.2% as shown in Table U2) and 2) these withdrawals are not linked to the price of silver and there is no uncertainty over their size. As a result, the Adha celebration is a fitting placebo for our purposes. In Appendix U we report further evidence on this and we produce a similar test analogous to the one shown in Table 4, the difference being that, instead of calculating the volatility of silver price in the three months preceding the first day of Ramadan, we calculate the same measure for the three months preceding Eid al-Adha and standardize the measure as previously described. Table U3 shows that we cannot reject the null hypothesis of no effect on lending characteristics.

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

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

4.3.2 Alternative Hypothesis on Selection into the Timing of Lending

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

If the previous argument applies, then we should observe an abnormal decline (or increase) in banks' overall operations during the quarter in which Zakat takes place. As a result, we collapse the data at bank–time (quarter–year) level and verify two key indicators: 1) the loan number share, defined as the number of loans given in that quarter over the total number given in the year, and 2) the loan volume share, defined as the total volume of loans in PKR divided by the overall volume of loans given in the year. Appendix V, Table V1, shows the results both in the case of extensive margin in Panel A and intensive margin in Panel B, in which there does not emerge any movement in the overall activities of banks. Therefore, we can claim that, even if there may be selection in the timing of loans during the Zakat period, it does not appear either to be particularly severe or to change the number/volume of operations.

4.3.3 Alternative Explanation on the Quality of Lending

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

4.3.4 Alternative Effect on Bank Competition

One possible warning against the main results may relate to the role of bank competition. Because banks are heterogeneously exposed to deposit volatility, interpreted as a change in their marginal cost of lending, then firms could move from more affected banks (which raise the long-term rate more) to less affected ones (which may increase this less or not at all). Although this is plausible, this phenomenon is a limited one for three main reasons: 1) Pakistani firms tend to be credit constrained, in line with other South Asian economies as reported by Banerjee and Duflo (2014); 2) firms and banks tend to establish long-term relations, so that it may be cheaper to stay with the current bank and switch maturity rather than reallocate lending across banks (as shown theoretically in subsection "Bank Competition and Deposit Volatility" of Appendix B), and 3) large firms should benefit the most from competition because their cost of establishing relations with banks could be particularly low, but even they feel the existence of Zakat, given that they adjust their investment maturity to the lending one (as shown in Table 6). However, we also provide two empirical tests to verify and account for the possibility of cross-bank competition. We do this in two ways in Appendix X: 1) we show that firms do not switch banks in this period, by showing that the share of lending that firm f receives from bank b at time t does not correlate with the Zakat variables, and 2) we replicate the results of Table 4, controlling for the Herfindahl Index of loan share composition at firm level, both as a control and interacted with the firm fixed effect, which does not alter our main findings.

5 Policy Implications and External Validity

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

In Section 5.1, we discuss and quantify a policy counterfactual in which the State Bank of Pakistan introduces a targeted liquidity program in the three months before Zakat, in order to neutralize the effect of the silver price uncertainty. For example, during this period, this program could provide liquidity to banks at the average deposit rate and through an incentive-compatible mechanism, which leads to replace deposits without over-borrowing. Through the lenses of the theoretical model, such scheme would lower the long-term lending rate and not distort loan maturities toward the short-term. In order to quantify the plausible gains of this program, we combine results from the theoretical framework with the elasticities of the empirical section and find that such program would lead to an average annual output gains of 0.042% under the extensive margin and 0.205% under the intensive margin.

In Section 5.2, we contextualize this result in a cross-country view and show that low-income countries are likely to be affected more strongly by deposit volatility. In particular we focus on African countries, among which the majority exhibits a combination of high deposit volatility and a lack of financial institutions to stabilize bank liquidity. Within the framework of our model, this creates an infinite cost of liquidity, $r_{CB} \to \infty$, to which banks respond by "buying insurance" through short-maturity loans. One key policy recommendation from this section is

to establish, and stabilize, discount window facilities in Africa to boost long-term lending and investment.

5.1 Quantifying the Effect of a Targeted Liquidity Program

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

Exploiting the assumptions made in the theoretical section, we can quantify the output effects of Zakat, by using only information from the credit registry. This presents an obvious data advantage because we can use information that summarizes more than one million loans over almost a decade and with a credible identification.

In Appendix Y, we show that starting from the definition of output in the theoretical model, and through a few transformations, we can reach the following expressions

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

which respectively quantify how the output in the economy, $\overline{Y}$, and the average maturity, $\overline{M}$, change in presence of deposit volatility, v, for a given central bank rate r_{CB}. In this expressions, the subscript m reports the maturity class of a loan (1 year or less, 2, 3, 4 or 5 or more) as introduced in 4.2.2. 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 was estimated in 4.4.2. Similarly the expression for maturities is the sum of the product between the loan share and the rate response.

Table 6 reports the main results of this section given the average silver price volatility and combining both the extensive margin and the intensive margin of Zakat. Two key results emerge. First, the average gain of output generated by Zakat is 0.042% under the extensive margin and 0.205% under the intensive margin. Second, this program would lead to a general increase in loan maturities: 4.71% under the extensive margin and 22.79% under the intensive margin.

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), Schiantarelli and Sembenelli (1997), Schiantarelli and Jaramillo (2002) find through a production function estimation using panels of firms that longer-term finance is associated with productivity gains. Analogously Terry (2015) finds that quarterly reports lower firms output by 0.1%, within the interval of our estimates, by generating a reallocation away from R&D (long-term investment) to alternative

short-term activities. Although these studies start from different conceptual frameworks, they also conclude that the reallocation from long- to short-term investment tends to play the most important role in such a productivity effect.

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

Note that our results pertain to a specific type of deposit volatility, generated by fluctuations in silver price, and counterfactual liquidity program to address this narrowly defined problem. Nonetheless, the phenomenon we describe has more extensive applications relating to agriculture/weather fluctuations and policy-induced uncertainty. Also in terms of economic impact, although we can focus on only one margin of operation (i.e. short- versus long-term investment), there may be a variety of additional outcomes that need to be considered: job creation and its long- versus short-term effects, knowledge spillovers generated by the move toward a capital-intensive economy and the international trade dimension of this. Note also that, although our methodology allows us to use exclusively information from the credit registry, this comes at the cost of accepting the specific assumptions of the model (i.e. functional forms of firms' productivity and shock, perfect competition in production and finance), which may limit the generality of the current exercise. Finally, we are not accounting for the possible side effects of this policy (e.g. inflation, moral hazard), which may depend on the execution of the liquidity program.

Table 6: Output Gains of a Targeted Liquidity Program

(1)	(2)	(3)
Variable	Extensive Margin	Intensive Margin
Output Gains	0.042%	0.205%
Maturity Increase	4.71%	22.79%

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

5.2 External Validity and Policy Implications

Although the existence of the bank maturity channel does not depend on the income level of a country, it is likely to be more relevant in low-income countries for the following three reasons. First, their financial systems are mostly bank-based, as Figure 7 shows when we correlate the

bank share of financial assets with log GDP per capita both for cross-country in 2010 (left panel) and for the USA between 1897 and 2002 (right panel). Second, their banks are largely deposit-funded, as the left panel of Figure 8 shows when we correlate the country-average deposit share of bank liabilities with log GDP per capita. Third, their deposits are more volatile, as the right panel of Figure 8 shows when we correlate a measure of deposit volatility with log GDP per capita and their financial systems exhibit high discount rates or, often, non-existent liquidity markets, as discussed below and in Appendix Z.

Consistently with the bank maturity channel, we observe that low-income countries present both a higher volatility of bank deposits and, correspondingly, loans with short maturities, as originally shown in Figure 1. Whereas the first result is consistent with the volatility and development literature,[24] the second result has been emerging steadily in the past few years. In terms of relevance, the lack of long-term finance is a traditionally debated issue.[25] Our mechanism places banks and their lending incentives at the centre. This is in line with the thoughts of policy makers, who acknowledge the lack of long-term finance as a supply problem and banks as responsible for this. In this respect, the Global Financial Development report by the World Bank (2015) presents a survey of financial development among financial sector practitioners (bankers, central bankers, regulators, academics), and two important messages emerge from this survey: 1) access to long-term finance is a supply problem (75% of respondents agree) and 2) domestic banks play the most important role in access to long-term finance (61% agree).

The results of our channel and empirical analysis show that one reason behind this "long-term loan supply" problem may be related to the lack of a steady, predictable and accessible flow of liquidity to commercial banks. In fact, as the upper panel of Figure Z1 in Appendix Z shows, most banks in low-income countries do not have access to local interbank markets, with data on interbank lending consequentially not available from the Bankoscope database. At the same time, most banks from low-income countries do not have access to international capital markets either because of local regulation or because these lack any international reputation. As a result, most banks tend to rely on the discount window facility, which is the liquidity offered by the national central bank. In fact, as Figure Z2 shows that, where available, banks borrow extensively from their local central bank.

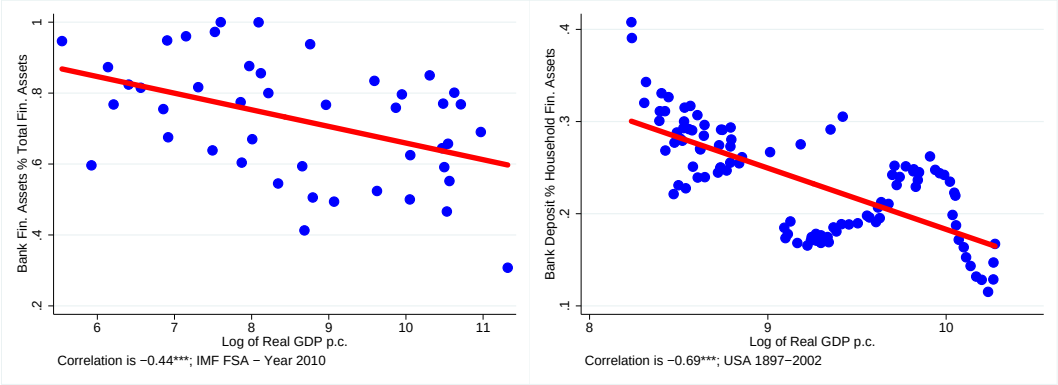
However, not all countries have established the legal framework under which the central bank can lend to commercial banks. In other cases, even when this is clear, central banks may purposefully restrict access to liquidity on an unpredictable basis. These results are reported

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

[25] For example, the original debate on the creation of the World Bank was centred around its role as catalyst for long-term finance and investment. Moreover, various multilateral institutions and government fora have been discussing the lack of long-term finance and investment in low-income countries, proposing a variety of policy recommendations in this direction. Refer to the umbrella paper on "Long-Term Investment Financing for Growth and Development", available at http://g20.org/English/Documents/PastPresidency/201512/P020151225691284966192.pdf.

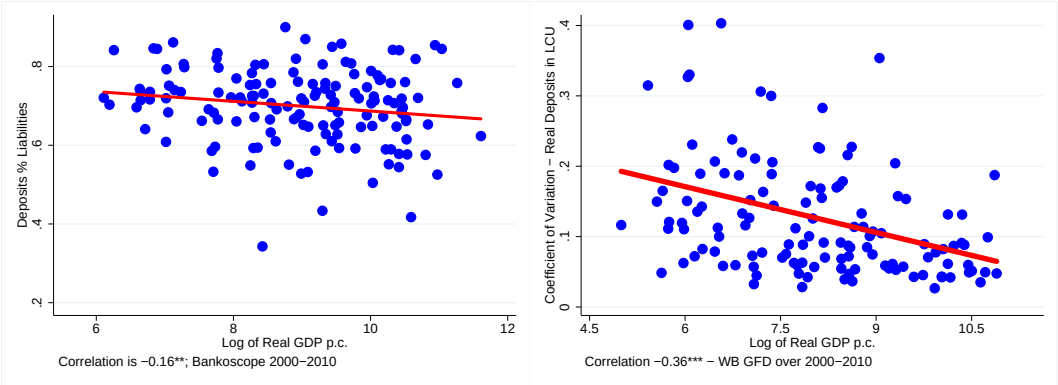
in Table Z1 (see Appendix Z), in which we have collected for all countries in Africa the status of their discount window facilities, as described by local or IMF/World Bank documentation. Linking this back to our theoretical model, in absence of alternative liquidity for commercial banks, then its implicit cost tends to infinity $r_{CB} \to \infty$. This makes long-term finance infinitely costly for banks and generates extensive redirection toward the short term. This seems to be the case in many African countries whose banks lack interbank markets, international liquidity market access and discount window facilities, such as Ethiopia, Liberia and Guinea.

Figure 7: Bank Financial Asset Share and GDP per Capita



Notes: This figure shows scatter plots between the share of financial assets held in banks on the y-axes and the log of real GDP per capita (p.c.) on the x-axes. The left panel reports for 48 countries in 2010, and the right panel for the USA between 1987 and 2002. The correlation between these two variables is, respectively, -0.44 and -0.69, statistically different from zero at 1% in both. Data in the left panel are from the annual Financial Sector Assessment report conducted by the IMF in each country; data on log of the GDP per capita are in 2005 constant dollar from the Penn World Tables (Feenstra et al. (2015)). Data in the right panel are from the Historical Statistics of the United States. Between 1897 and 1945, statistics are from the table on "Personal Saving, by Major Components of Assets and Liabilities", contributed by John A. James and Richard Sylla in Carter et al (Historical statistics of the United States: millennial edition). Data on GDP per capita over the whole period in 1897–2002 USA are expressed in 1990 Int. GK$ from the Maddison Project (Bolt and Zanden (2014)).

Figure 8: Deposit-Funded Banks and Deposit Volatility



Notes: The left panel shows a scatter plot between the deposit share of liabilities on the y-axis and the log of real GDP per capita on the x-axis. Data on the deposit share are from the Bankoscope database. Each dot is a country observation,and from the Bankoscope database we take a country average of bank-level observations. The correlation is -0.16 and statistically different from zero at 5%. The right panel shows a scatter plot between the log real GDP per capita (p.c.) on the x-axis and the variation coefficient of cyclical real bank deposits over the same period on the y-axis. Data on log of the GDP per capita are in 2005 constant dollar from the Penn World Tables (Feenstra et al. (2015)); bank deposit data are from the Global Financial Development database available in World Bank (2015). The correlation between these two variables is -0.36 and is statistically different from zero at 1%. All presented data on GDP and deposits are between 2000 and 2010.

6 Conclusions

In this paper, we proposed a mechanism through which the interaction between bank deposit volatility and discount rate can alter banks' lending incentives. The higher the cost of accessing

alternative liquidity to replace volatile deposits, the higher the tendency of banks to pass this cost onto long-term rates, which consequently promotes a shortening of loan maturities, leading to less long-term investment and output.

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

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

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