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Do interest rates matter? Credit demand in the Dhaka slums ☆

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ABSTRACT

"Best practice" in microfinance holds that interest rates should be set at profit-making levels, based on the belief that even poor customers favor access to finance over low fees. Despite this core belief, little direct evidence exists on the price elasticity of credit demand in poor communities. We examine increases in the interest rate on microfinance loans in the slums of Dhaka, Bangladesh. Using unanticipated between-branch variation in prices, we estimate interest elasticities from −0.73 to −1.04, with our preferred estimate being at the upper end of this range. Interest income earned from most borrowers fell, but interest income earned from the largest increased, generating overall profitability at the branch level.

1. Introduction

The advent of microfinance lending in the last two decades has been hailed as a key tool for reducing poverty, marked notably by the 2006 Nobel Peace Prize awarded to Muhammad Yunus and Grameen Bank of Bangladesh. Microfinance involves new banking institutions that work in poor communities, aiming to achieve both financial viability and transformational social impacts. New credit contracts have led to surprisingly high loan repayment rates (most established microlenders claim repayment rates well above 95%), and economists have focused on the way that contracts mitigate adverse selection and moral hazard, problems that undermined alternative attempts to lend to poor households without collateral (e.g., Laffont and Rey, 2003; Rai and Sjöström, 2003; Stiglitz, 1990).[1]

But high repayment rates are insufficient to drive a global movement. The key to the expansion of microfinance, it is argued, depends on the success of microfinance as a commercial phenomenon, free from subsidy (Drake and Rhyne, 2002; Robinson, 2001). The promise hinges as much (or more) on the ability to contain costs and to price loans at interest rates that are high enough to generate profits. Once profitability is in hand, it is argued, microlenders can expand globally with minimal external support. The logic of this part of the microfinance revolution is built on the idea that poor households are willing and able to pay interest rates for loans that fully cover the costs of lenders. A corollary of this logic is that the poorest borrowers, who also tend to be the most expensive to serve, will pay the highest prices for capital.

Implicit in this argument is a key – and untested – assumption: that poor households of the kind that take advantage of microfinance are not very responsive to changes in interest rates. Specifically, it is argued that poor households primarily seek *access* to credit, not necessarily "cheap" credit. When poor households are not very sensitive to price changes, interest rates can be raised without losing the

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[1] The Microfinance Information Exchange (2007), for example, reports on a database of 704 leading microlenders. Their average portfolio at risk greater than 30 days is 2.8%.

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volume of lending on which microfinance expansion depends.[2] This key assumption remains largely unexplored in the academic literature, and is the focus of the present study. It is worth noting that there is broader motivation for investigating the interest elasticity of borrowing from microcredits. It has become increasingly appreciated that microcredits are just one (albeit typically the only formal-sector) source of financial services for the poor, and as such this elasticity is an important parameter in considering regulatory policy for the microcredit sector.

The main methodological difficulty is that the schedule of interest rates seldom varies within a given program, and, when it does change, it does so for all customers across the board. Thus it is typically impossible to disentangle the effect of the interest rate change from broader changes occurring simultaneously (e.g., macroeconomic shocks). It may be possible to compare customers of different institutions who face different interest rates at any given moment, but then researchers face the question of why some customers selected one institution and why others selected another. It is also difficult to disentangle the effects of non-price differences among programs. In this paper, we are able to test fundamental assumptions about price sensitivity by examining the effects on credit demand of a substantial and unexpected price increase, from 2% per month to 3% per month, imposed by a lender in the slums of Dhaka, Bangladesh.[3]

Other than Karlan and Zinman's (2008) study, we know of no other econometric estimates of interest elasticities for poor customers in low-income economies. Karlan and Zinman worked with a consumer lender in South Africa (rather than a traditional microfinance bank) that randomized the interest rates offered in solicitation letters advertising new loans, sent to former clients of the bank. They found that raising interest rates above the lender's standard rate (7.75 to 11.75% per month) led to substantial decreases in both the demand for loans and loan repayment, whereas below the standard interest rate, the demand curve sloped gently downward. We view our paper as complementary to Karlan and Zinman's South Africa study. While our study lacks the advantage of an experimental design, we are able to investigate outcomes for a lender that is in some ways more typical of the microfinance market both in terms of interest rate and target customers (although *Safe*Save differs from typical microcredit along other dimensions, such as making individual rather than group loans, as we discuss in Section 3, below).[4] There is, of course, a large literature examining interest elasticities of credit demand for high-interest or low-income borrowers in developed economies, for example Gross and Souleles (2002) study credit card customers and Skiba and Tobacman (2008) study payday loans.[5]

In turning to *Safe*Save, we investigate an innovative microlender operating in the slums of Dhaka, making small loans over longer durations at relatively modest interest rates (initially 24% per year). We use the administrative records of *Safe*Save to estimate patterns of demand. Identification is based on unanticipated between-branch variation in the interest rate. At the time of our study, *Safe*Save operated three urban branches, with slightly different products and prices in one of the branches. By comparing times at which product rules changed in two locations but not in the third, we can make inferences about the sensitivity of customer behavior to interest rates. While falling short of offering the opportunity to investigate randomized prices, the *Safe*Save data allow a clean comparison based on an unexpected policy change made within a single institution that maintains a uniform philosophy and operating protocol throughout.

Our results suggest that borrowers are sensitive to the interest rate increase. After controlling for generally upward trends in loans, the implied elasticities of loan demand with respect to changes in the interest rate range from −0.73 to −1.04 during the twelve months after the price increase in our preferred specifications. We find that borrowers tend to take smaller, more frequent loans, and repay more quickly, leading to a reduction in overall loan balances. The evidence suggests that the price increase helped *Safe*Save to improve its financial condition to some extent. Average interest income increased at the branch level and from larger-scale customers, but declined for other borrowers. Over the longer term, loan demand began to recover, but four years later it was not yet back to the level seen before the interest rate hike.

The paper is organized as follows. Section 2 reviews the debates on interest rates. Section 3 provides details on *Safe*Save. Section 4 summarizes our data. Section 5 outlines our identification strategy. Section 6 presents results on the interest elasticity of loan demand and profitability. Section 7 concludes.

2. Interest rate debates

The assumption of inelastic demand for capital is a radical break from past thinking. In the 1970s and 1980s, usury laws were common, and they restricted interest rates on loans to low levels in order to keep capital affordable to poor borrowers. These caps were often combined with directives on who should receive subsidized loans and for what purpose.[6] The laws were driven by the belief that high interest rates on working capital would consume most of the surpluses generated by small-scale entrepreneurs, leaving borrowers

[2] This argument has held greater force in Latin America and Africa, where microfinance interest rates have tended to be higher, than in South Asia, where fears are more often expressed that high interest rates will deter promising clients and diminish social and economic impacts on households. Cull et al. (2009) give an overview of global data and debate.

[3] Other open questions about microcredit include the rate of return in micro-enterprises (de Mel et al., 2008), the impact of microcredit access on borrowing households (Banerjee et al., 2009), and the role of contracting mechanisms (e.g., Giné and Karlan, 2009).

[4] The South African lender offered borrowers small cash consumer loans (the median size was $150) taken for short durations (typically for just one month) at high interest rates (30% per month, with inflation below 10% per year in most years). In this, the institution's operating mode and pricing structure shares strong similarities with "payday lenders" in the United States (see, e.g., Caskey, 2005), more than with the leading microfinance institutions included in Microfinance Information Exchange (2007). As a comparison, the leading South African Grameen Bank replicator charges effective interest rates of 60–75% per year (Collins, 2007) and designates that loans be used to support small-scale enterprise. Collins et al. (2009), chapter 6, describe the large differences between nominal, effective, and annualized loan prices in South Africa and differences in the willingness to pay for loans based on their size and maturity. *Safe*Save loans resemble the South African lender in their short duration, but are smaller in scale (closer to $20) and at a lower interest rate (24–36% per year).

[5] Gross and Souleles (2002) provide estimates of the sensitivity of credit card customers in the United States to interest rate changes. Their findings are in the same range as ours. They find that the long-run (at the end of one year) elasticity of debt to the interest rate is −1.3, which is greater (in absolute value) than our estimates, but they find a smaller (in absolute value) elasticity for interest rate increases than decreases. Under half of their elasticity comes from shifting balances between accounts and the rest is from reduction in total debt. Related papers include estimates of price sensitivity by Alessie et al. (2005) in a study of consumer lending in Italy, and by Attanasio et al. (2007) on U.S. car loans. Karlan, Zinman and collaborators are presently estimating interest elasticities in Mexico, Peru, Ghana, and the Philippines.

[6] See, for example, the critical discussion in Adams, et al. (1984). Homer and Sylla (1996) document how attitudes toward interest rate restrictions have swung widely through time. They begin with Hammurabi, King of Babylonia in about 1800 BCE, who restricted interest rates on grain loans (to be repaid in kind) to 33 1/3% per year. Rates on loans in silver could be no higher than 20% per year. The ancient Greeks did away with restrictions under Solon's rule, but the Romans brought them back, limiting charges on loans to 8 1/3% per year. Charlemagne forbade all interest, a view continued by most theologians in the Middle Ages, only to be undone in northern Europe with the Reformation. England continued without restrictions, while in the contemporary United States individual states set limits on interest rates on personal loans at around 30–45% per year. In developing countries today, interest rate restrictions remain the norm, and in many cases special laws have had to be written to give microlenders the leeway needed to work in poor communities while covering costs.

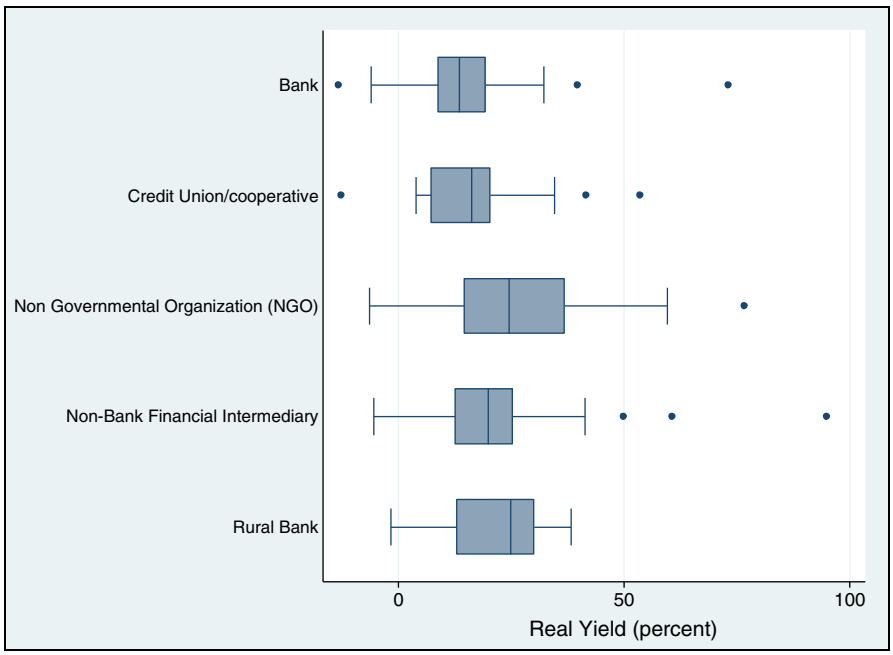


Fig. 1. Real yields on gross microfinance portfolios, by institutional type 2002–4 (n = 346). Notes: Average real yields are total cash financial revenue from lending divided by the average gross loan portfolio, adjusted for inflation. They give a measure of average interest rates for the institution. The edges of the boxes give the 25th and 75th percentile of the variable. The line in the middle of the box gives the median. The "whiskers" that extend give the 5th (left whisker) and 95th percentiles (right whisker).
Source: MixMarket data analyzed by Cull et al. (2009).

with little net gain. In Brazil in the early 1970s, for example, interest rates on loans for working capital were fixed at 17% per year while inflation rates ranged from 20 to 40% per year (Sayad, 1983, p. 381). Even where interest rate caps allowed positive real interest rates, they were seldom high enough to permit banks to cover costs. As a result, lending to the poor was a heavily-subsidized activity, monopolized by state-run banks. Too often, the subsidized resources went to non-poor households and political elites. Financial services tended to be low-quality, and scale was constrained by the size of government budgets.[7]

Microfinance advocates challenged the assumptions upon which the state-subsidized banks were built. Most microfinance interest rates now fall between 20% and 50% per year (in places where inflation runs no higher than 10% per year), and advocates argue that the surpluses from access to loans are ample enough to justify the high rates. The Microfinance Information Exchange (MIX, 2007) divides their sample of 704 microlenders into four categories, depending on the target market. For those on the "low end" (having an average loan size smaller than $150 or an average loan size divided by gross national income per capita under 20%) total expenses consumed 30.5% of assets for the median institution. To meet those costs, the median effective real interest rate was 27.5% per year, and the median institution was just on the brink of profitability (the average real interest rate is the financial revenue from the loan portfolio as a fraction of the average gross loan portfolio, adjusted for inflation). Fig. 1 depicts the distribution of average interest rates in the Microfinance Information Exchange data, disaggregated from the MIX 2002–4 sample by Cull et al. (2009). The "low-end" lenders overlap considerably with the NGOs shown in Fig. 1, whose average real interest rates span from about 20% at the 25th percentile to about 40% at the 75th percentile.

Given an inflation rate of 6% in Bangladesh in 2000, *Safe*Save's price change from 2% per month to 3% per month moved it from a real interest rate around 18% per year to a real rate of around 30% per year, in line with the effective prices charged by two major Bangladeshi microlenders, BRAC and ASA.

The latter prices are higher than the favored rate of Grameen Bank founder Muhammad Yunus (2007), whose view is: "A true microcredit organization must keep its interest rate as close to the cost-of-funds as possible…My own experience has convinced me that microcredit interest rates can be comfortably under the cost of funds plus ten percent, or plus fifteen percent at the most." A rough indicator of the cost of funds for the "low end" microfinance institutions surveyed by the Microfinance Information Exchange (2007) is given by the ratio of financial expenses to assets. The ratio is 6.1%, suggesting that Dr. Yunus favors interest rates around 20% per year, the approximate interest rate charged by Grameen Bank in Bangladesh.[8] In this context, *Safe*Save was making a major leap upward.

But donors who are shaping microfinance policy have spent much effort making the argument that raising real interest rates to 30% per year and higher is unlikely, in fact, to dissuade credit-worthy borrowers (e.g., CGAP, 1996). The donors' assertion stems from two ideas. The first is that marginal returns to capital diminish with scale. If that is so, poor borrowers who are starved for capital ought to have high marginal returns to their investments—and ought to be willing to pay high interest rates as a result (CGAP, 1996). The second idea is that poor households already pay very high interest rates to moneylenders (often 100% per year or more), so that if poor households can keep moneylenders in business, it should be no surprise that loans at half the moneylender rate (and in the case of *Safe*Save with a similar flexibility of repayment) are welcomed. Influential advocates now argue that poor households are so insensitive to interest rates that the standard practice ought to be to set fees high enough that institutions generate profits, cutting donors out of the loop after a short period of start-up subsidies. If this is so,

[7] The phenomenon is part of a broader problem of financial repression described by McKinnon (1973).

[8] Personnel costs turn out to drive microcredit interest rates more than capital costs. At interest rates of 20% per year, most microfinance institutions focusing on the poorest households would not be profitable given their current cost structures—and Grameen Bank has relied on subsidies for most of its history (Cull et al., 2009).

microfinance can readily expand to serve the hundreds of millions of currently excluded households, without sacrificing depth of outreach.

This claim is far from clear as a general proposition. First, the assumption of diminishing marginal returns to capital disregards the possibility of non-convexities in production processes and unequal access to non-capital inputs like managerial skills and human capital. Moreover, raising interest rates can in principle exacerbate moral hazard and adverse selection, worsening loan repayment rates and screening out the most reliable borrowers.[9] And, while microlenders may still find a pool of customers after real interest rates are raised, the customers may not be from the same pool that was willing and able to pay the lower rates. Fears like these, coupled with a strongly-felt moral imperative to keep costs as low as possible for the poor, have compelled the larger microlenders in South Asia to keep real interest rates below 40% per year, even if it means turning to subsidized resources to cover costs (e.g., Morduch, 1999).

3. The *Safe*Save program

About one third of Dhaka's 11 million inhabitants live in slums. Most adult slum residents are poor but working, finding informal sector jobs such as being a driver, domestic help, or construction worker. Some find work in factories, particularly in the garment industry. The slums have active economies of their own, but they are poorly served by formal financial intermediaries. Instead, traditional means of saving and borrowing, like joining rotating saving and credit associations (ROSCAs) or finding a friend willing to serve as a "money guard", are common ways to manage funds.[10]

*Safe*Save was launched in 1996 with the mission of offering its clients "the most convenient possible way to turn their savings into usefully large sums of money."[11] The result is a structure and product line that differs from typical microfinance institutions—even though the customer base is similar. Most microlenders, especially in Bangladesh, offer rigidly structured loans targeted to business investment; whether or not loan contracts feature joint liability, transactions typically take place in weekly group meetings in villages and neighborhoods. *Safe*Save, in contrast, highlights flexibility, ties lending to saving, has no expectation that loans will be used for business investment, and deals with customers on a strictly individual basis. These features make SafeSave data particularly rich for the present study, as we are able to analyze a wide range of choices (size of loans, speed of repayment, time between loans, etc.) that are not meaningfully made in highly structured programs. The features also suggest useful comparisons with mainstream consumer finance lending (serving more affluent customers), such as that studied by Gross and Souleles (2002) and Karlan and Zinman (2008).

*Safe*Save clients are served by "collectors" who visit them in their homes or businesses six days a week. Each day, clients can choose to add to their savings, pay down loans, or to draw down their savings, in amounts that are variable and freely chosen. Clients must visit the branch office only to withdraw more than 500 taka in a day or to get a loan. Once clients obtain a loan, they can pay it back on their own schedule — in small frequent bits, in a lump sum, quickly, or stretched out over time. The only stipulation is that interest on the outstanding balance must be paid each month. While borrowers are required to hold savings accounts, savers are not required to borrow; at any time, about two thirds of clients hold loans. None of the loans requires assets to be pledged as collateral, although, as we describe below, a form of "financial collateral" is employed.[12]

The first *Safe*Save branches were in western Dhaka. Apart from residence in the slum, there are no additional eligibility requirements or means tests. The first branches served were in Tikkapara and Kalyanpur, a mix of densely-populated slums where squatters live in rows of lightweight huts built on bamboo frames, with woven bamboo walls and, in better circumstances, tin roofs. The third branch was opened in Geneva slum, a community of Bihari refugees with government-provided concrete housing along a grid of narrow lanes. The analysis below compares the effects of an interest rate change at Tikkapara and Kalyanpur to ongoing conditions in Geneva.

The residents of the slums in which *Safe*Save works are described as being "poor according to any standard one could possibly set." Moreover, "uncertainty regarding food is very much an every day worry for many. Education of adults is very low with a high incidence of illiterate people, and in spite of great achievements in school enrollment numbers in Bangladesh … a large proportion of school age going children… are not going to school." (Cortijo, 2005, p. viii). The population substantially overlaps with populations served by large microlenders like Grameen Bank and BRAC (Cortijo, 2005, 35–36).

It is important for the subsequent analysis to understand what motivated the interest rate increase and its timing. Based on interviews with *Safe*Save, the increase in interest rate was not based on trends, either past or anticipated, in savings or borrowing, but instead on the two goals of achieving financial self-sustainability for the Tikkapara and Kalyanpur branches and of bringing the rules in these two branches in line with *Safe*Save's latest program which was being offered in Geneva. Furthermore, the exact timing of the changes appears to have been both arbitrary and unexpected for borrowers (and even loan officers).[13]

Before moving on to discuss the data and estimation techniques used, one more feature of the *Safe*Save program merits particular attention for the purposes of this study. Unlike a situation in which customers move from one equilibrium to another with little else in the environment changing but the price, *Safe*Save program rules mean that clients are steadily building up savings and the capacity to borrow. For example, in Tikkapara and Kalyanpur, clients are not allowed to borrow until they have been members for at least two months and their savings have reached 500 taka (just under $10 in January 2000).[14] At that point they can borrow their saving balance plus 1000 taka. The next time, they can increase the loan size by another 500 taka, and so on, without limit, adding another 500 taka to their credit limit with each successive cycle. (Geneva has a similar policy. The exact rules are in Appendix A.) In addition, new customers are also joining, and some older customers are beginning to depart. Because we have records for all customers, past and present, concern with attrition is limited here, but we pay close attention to the underlying upward trends in borrowing and saving. It is against those trends that we look for changes in the demand for borrowing in response to the interest rate change.

4. The data

After making their daily rounds to the homes and businesses of their customers, the records of *Safe*Save collectors are entered into database software for use by management. We use the daily data to calculate

[9] The arguments are reviewed in Armendáriz and Morduch (2010). McKenzie and Woodruff (2006) give evidence from Mexico that shows no signs of non-convexities in production for small-scale entrepreneurs.

[10] See Rutherford (1997) for a survey of informal finance in the Dhaka slums. A second survey in the Dhaka slums by Rutherford is described in Collins et al. (2009). The two studies provide rich data on small samples. In contrast, the present study takes advantage of a large sample but just a limited number of variables.

[11] The quote is taken from www.safesave.org in April 2004.

[12] Armendáriz and Morduch (2010) describe the use of financial collateral and its rationale.

[13] As Stuart Rutherford, the founder of *Safe*Save, remembers the switch: "It was fairly arbitrary… I don't think there was anything special about February 2000 — it is just that by then the pro-rise argument finally prevailed in the discussions that I had with [the senior staff]." Email correspondence, March 6, 2005.

[14] On January 1, 2000, one US dollar was worth 50.85 taka. So 500 taka in 2000 are worth $9.83. The loans are sizeable relative to average assets. By comparison, a survey conducted in April 2005 found that the average asset holdings of a representative sample of new *Safe*Save clients was 1000 taka (Cortijo, 2005, Table 11, p. 33). In May 2005, one US dollar was worth 62.5 taka, so 1000 taka are worth $16.

Table 1
Descriptive statistics of *Safe*Save accounts monthly averages, January 1999–January 2001.

	Observations	Mean	Standard deviation	Minimum	Maximum
Tikkapara and Kalyanpur branches					
Client characteristics					
Female	54,522	0.64	0.48	0	1
Age	54,522	26.9	10.7	4	94
Account characteristics					
Savings deposited	54,522	43.2	128	0	11,675
Saving balance	54,522	579	978	0	30,347
Savings withdrawn	54,522	26.9	159	0	9823
Loan (initial amount)	3675	1384	729	424	6446
Length of loan cycle (months)	54,522	0.81	1.13	0	10
Loan balance	54,522	434	665	0	6501
Amount of loan repaid	54,522	65.6	223	0	4772
Geneva branch					
Client characteristics					
Female	13,515	0.67	0.47	0	1
Age	13,515	27.5	10.7	2	94
Account characteristics					
Savings deposited	13,515	44.1	76.8	0	1880
Saving balance	13,515	217	409	0	13,803
Savings withdrawn	13,515	36.5	129	0	6489
Loan (initial amount)	2568	891	476	43	3393
Length of loan cycle (months)	13,515	1.30	1.36	0	80
Loan balance	13,515	480	545	0	3365
Amount of loan repaid	13,515	103	276	0	3887

Notes: Financial variables are reported in 1985 taka (authors' calculation based on *Safe*Save customer records). To convert the data into January 2000 dollars, divide by 22.1. Each observation is the monthly aggregate of a *Safe*Save account at one of the three branches.

basic measures of saving and borrowing and then aggregate them to the monthly level. There is rarely more than one loan taken per month and interest payments are due monthly, so little relevant information was sacrificed through aggregation. In addition to financial variables, we also know the customers' ages, gender, and length of time with *Safe*Save. Given the long time-series dimension, we can control for time invariant unobservables using account-level fixed effects.

Most of the analysis focuses on 68,037 month-customer observations between January 1999 and January 2001. They reflect data on 5147 customers, not all of whom participate in the program during the entire period. The change in interest rate occurs midway through the sample, in February 2000.

Table 1 provides summary statistics for the sample, restricted to the dates we study. Two thirds of the clients are women or girls with an average age in the late twenties.[15] The financial data show that in all three branches, monthly deposits to savings are small, averaging about 44 taka (or 2.07 US dollars). All nominal values are converted into 1985–86 taka using the urban Consumer Price Index (the nominal exchange rate was 50.85 taka to one US dollar in January 2000, implying an exchange rate of 22.1 1985–86 taka to one US dollar). In Tikkapara and Kalyanpur, which had started several years before Geneva, accumulated savings balances averaged 579 taka (or $26), while in Geneva the average savings balance was 217 taka (or $10). Average loan sizes are small relative to those from other microlenders (at 1384 taka, or $65, in Tikkapara and Kalyanpur and 891 taka, or $37, in Geneva), and the typical length of a loan cycle is short, approximately one month between the time a loan is taken and repaid. Loan balances (which reflect partial repayments) are similar in the branches — about 434 taka ($20) in Tikkapara and Kalyanpur and 480 taka (or $22) in Geneva. Each repayment is relatively small, 200 taka (or $9.25) in Tikkapara and Kalyanpur and 405 taka (or $18.66) in Geneva, corresponding on average to repaying a quarter of the loan each week or half every two weeks.

Fig. 2 plots the main data used in this study, average monthly loan balances, versus a fitted linear trend line for each. The vertical line marks February 2000, the month the interest rate increased from 2% to 3% per month in Tikkapara and Kalyanpur. Before the interest rate increase, borrowers in the Tikkapara and Kalyanpur branches were subject to a lower interest rate than those in Geneva branch, which started with a 3% per month interest rate when it opened. But all three branches face a common set of macroeconomic shocks and borrowing capacity for borrowers in both branches is growing over time according to the *Safe*Save program rules explained above. We expect the difference in interest rates to be reflected in a level difference in borrowing between the branches, and common macroeconomic shocks and increases in borrowing capacity effects to be reflected in a common time trend.

These patterns are corroborated in Fig. 2. Prior to the announced interest rate change we find a level difference in average loan balances between branches, with higher balances in Tikkapara and Kalyanpur as expected. Consistent with the view that the two sets of branches experience the same macro shocks and similar growth in savings and borrowing capacity, we find a common upward linear trend: the trend difference is small economically (approximately 3 taka per month) and is not statistically significant. With the interest rate hike in 2000, there is a clear and statistically significant reduction in trend growth for average loan balances in the Tikkapara and Kalyanpur borrowers. In contrast, for Geneva, which did not experience any change in program rules, we find no statistically or economically significant reduction in trend or intercept.[16]

5. Estimation and identification

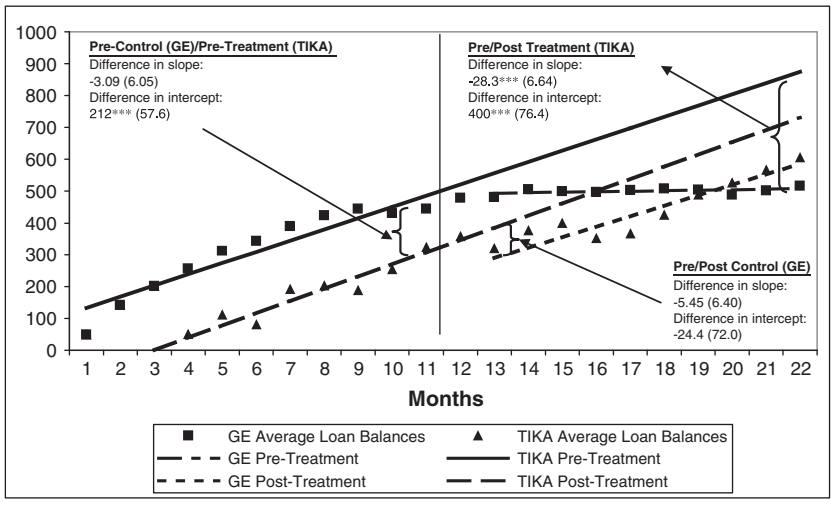
Features of the data plotted in Fig. 2 suggest a differences-in-differences estimator. Identification of the impact of the February 2000 interest rate increase from 2% per month to 3% per month exploits the fact that the change occurred in Tikkapara and Kalyanpur branches, but not in Geneva Branch[17], and hinges on two assumptions: the presumed lack of correlation of the timing of the interest rate change with other events occurring in Tikkapara and Kalyanpur and the plausibility of Geneva as a comparison for Tikkapara and Kalyanpur. Based on interviews with *Safe*Save, the first assumption seems to be satisfied: the timing of the switch was both arbitrary and unexpected from the perspective of loan officers and borrowers.

We test the second assumption in Fig. 2, as discussed in Section 4 (and in Table 2, which we discuss below). The data show that there is no statistically significant difference in the trend of borrowing in Tikkapara and Kalyanpur compared to Geneva prior to the interest rate increase. We also find that there is no significant pre-treatment versus post-treatment trend or level difference in borrowing in Geneva. Although this is not required for our differences-in-differences estimator, it bolsters the plausibility of Geneva as a comparison for Tikkapara and Kalyanpur, suggesting that Geneva did not experience any shocks or other changes that coincide with the interest rate increase in Tikkapara and Kalyanpur. Overall, the data corroborate the differences-in-differences assumptions, showing that Tikkapara and Kalyanpur share a common pre-treatment time trend with Geneva and that Geneva continues on this trend in the post-treatment period.

[15] *Safe*Save clients may open savings accounts in the names of their children, which is why the minimum age of account holders reported in Table 1 is quite young.

[16] Although the unadjusted data seem to show a drop in the intercept for Geneva borrowers in the post-period, our empirical analysis in Section 6, below, shows the intercept difference to be statistically insignificant. Specific intercept and trend coefficient estimates reported in Fig. 2 are from Table 2, column 3.

[17] Impact is calculated after January 2000, the announcement date of the increase. Since the interest rate change applied to both new and existing loans, existing *Safe*Save clients were given one month notice before the change was implemented.



Notes: Intercept and slope coefficient estimates from Table 2, column 3. Standard errors in parentheses.
** indicates significance at 5 percent; *** at 1 percent

Fig. 2. *Safe*Save Geneva and Tikkapara–Kalyanpur branches average loan balances plotted on linear trend.[20] Notes: Intercepted and slope coefficient estimates from Table 2, column 3. Standard errors clustered by month appear in parentheses. ** indicates significance at 5 percent; *** at 1 percent.

[20] For exact specification see Table 2, column 3.

We begin with a simple difference-in-difference specification:

$$y_{it} = \beta_0 + \beta_1 Treated_i + \beta_2 Post_t + \beta_3 Treated_i \times Post_t + \varepsilon_{it} \qquad (1)$$

where: i indexes clients and t the month; y_{it} is the dependent variable (typically average monthly loan balances, but also an indicator for loans, amount loaned, and repayments); $Treated_i$ takes on a value of 1 for individuals in Tikkapara and Kalyanpur and 0 for those in Geneva; and $Post_t$ refers to time periods after the interest rate increase. Hence, β_3 gives the impact of the interest rate increase: the change in borrowing before and after the interest rate increase in Tikkapara and Kalyanpur, relative to the contemporaneous change in Geneva. Standard errors are clustered at the month level.[18]

We proceed to refine this estimation strategy along a number of dimensions. First, we control for borrower characteristics, including age and length of time the account-holder has been with *Safe*Save ("time in program"). Second, rather than simply controlling for time effects with a before-versus-after dummy, we include a full set of month–year dummies. We then control for all non-time-varying differences between the treatment and comparison groups by including fixed effects for each individual borrower.

We then expand our baseline finding to consider the heterogeneity of responses as we narrow the estimation window and control for borrowing capacity. The latter is controlled for by calculating each individual's maximum borrowing capacity based on *Safe*Save's product rules. This is an important advantage of the data we are using because individuals might respond differently to changes in the interest rate based on their ability to borrow. For example, individuals with low (or zero) borrowing capacity cannot significantly respond to changes in interest rates. Since borrowing capacity hinges in part on savings behavior, and since savings behavior is likely to be jointly determined with borrowing, there is a concern that simultaneity and, possibly, omitted variables will bias the results. We thus instrument for capacity using the length of time the accountholder has been with *Safe*Save. Time in program is a valid instrument for capacity under three assumptions, all of which seem reasonable for our data: exogeneity (since time in program increases linearly it is unlikely to be correlated with simultaneous shocks to borrowing and saving), relevance (the longer individuals are in the program typically the more savings they accumulate), and exclusion (assuming we have correctly computed borrowing capacity, which is reasonable since we observe all the information that *Safe*Save does, then the only reason that time in program should affect borrowing is through savings and, in turn, capacity).

Next, we look at long-run effects of the interest rate change. Fig. 2 shows that, despite differences in interest rate charges (3% per month at Geneva and 2% per month at Tikkapara and Kalyanpur), loan balances at all three branches are growing at a roughly similar upward trend, presumably driven by a common macroeconomic environment and the on-going growth in borrowing capacity that the program creates. We then see a significant fall in trend loan growth in Tikkapara and Kalyanpur after the interest rate at those branches was raised to 3% per month in February 2000. These patterns in the data raise the question of whether borrowing patterns in Tikkapara and Kalyanpur will eventually converge to a new steady state similar to Geneva. We explore that question by examining differences in loan balances and the disbursement of new loans in a long-run post-treatment sample.

We close by investigating impacts on interest income and profitability from the lender's vantage. Using branch balance sheet data, we examine the impact of the treatment on profits per branch and profits per client. We then return to our client-level data, aggregated to the branch level, to examine treatment impacts on interest income and loan write-offs. Finally, we explore possible heterogeneity in the impact of the interest rate increase on interest income among long-term clients that were *Safe*Save clients well-before the interest rate hike (and remained after the change), new clients who joined after the interest rate change, and clients who maintained the largest loan balances.

6. Results

6.1. Interest rate effects on loan balances

We begin by looking at a simple first difference in monthly loan balances before and after the interest rate increase in Tikkapara and Kalyanpur. Columns 1 and 2 of Table 2 report the trend coefficient is positive across all branches, reflecting the upward trend in overall loan balances seen in Fig. 2. As discussed above, we see in column 3 that the coefficient on the interaction of the treatment and time trend shows that there is no statistically significant difference in trend

[18] Clustering standard errors by branch leads to lower standard errors; hence, we opt for the more conservative strategy of clustering by month.

Table 2
Interest rate effects on loan balances.

	(1)	(2)	(3)	(4)
Sample	Tikkapara and Kalyanpur branches	Geneva branch	Full sample (Tikkapara, Kalyanpur and Geneva branches)	Full sample (Tikkapara, Kalyanpur and Geneva branches)
Specification	OLS	OLS	OLS difference-in differences	OLS difference-in-differences
Dependent variable	Monthly loan balances	Monthly loan balances	Monthly loan balances	Monthly loan balances
Treatment × Post × Trend			−28.3***	−24.4***
			(6.64)	(6.32)
Treatment × Post			400***	330***
			(76.4)	(72.8)
Treatment × Trend			−3.09	−7.99
			(6.05)	(5.76)
Trend × Post	−33.7***	−5.45	−5.45	−8.67
	(1.84)	(5.20)	(6.40)	(6.09)
Treatment			212***	35.8
			(57.6)	(54.9)
Trend	35.3***	38.4***	38.4***	31.4***
	(1.19)	(4.82)	(5.94)	(5.66)
Post	375***	−24.4	−24.4	38.6
	(26.6)	(58.5)	(72.0)	(68.6)
Age				1.87***
				(0.22)
Time in program				23.0***
				(0.30)
Constant	97.8***	−114**	−114**	−165***
	(8.94)	(46.2)	(56.9)	(54.7)
Observations	49,551	10,955	60,506	60,506
R^2	0.034	0.056	0.036	0.13

Notes: For all columns, the dependent variable is monthly loan balances. In columns 1 and 2, the samples are the treatment branches (Tikkapara and Kalyanpur) and the comparison branch (Geneva) respectively, and we include a linear time trend, an indicator for the post time period (i.e., after loan interest rates were hiked in Tikkapara and Kalyanpur branches in February 2000), and an interaction of the two. In column 3, we expand the sample to include both treatment and comparison branches, and estimate the same specification along with an indicator for treatment branches ("Treatment") and interactions of Treatment with other variables. In column 4, we add additional controls: age (the age of the client in years) and time in program (the length of time the accountholder has been with *Safe*Save). The full sample includes all 60,506 monthly client observations at all three branches — Tikkapara, Kalyanpur and Geneva, over the period of our study, January 1999–January 2001. Standard errors clustered by month appear in parentheses. ** indicates significance at 5%; *** at 1%.

Table 3
Interest rate effects on loan balances — difference-in-differences.

	(1)	(2)	(3)	(4)
Sample	Full sample	Full sample	Full sample	Balanced sample
Specification	OLS diffs-in-diffs	OLS diffs-in-diffs	OLS diffs-in-diffs	OLS diffs-in-diffs
Dependent variable	Monthly loan balances	Monthly loan balances	Monthly loan balances	Monthly loan balances
Treatment × Post	−92.7***	−157***	−209.1***	−357.4***
	(17.4)	(16.5)	(16.6)	(42.3)
Treatment	93.6***	−105***	−41.3***	176.8***
	(15.9)	(15.3)	(15.5)	(43.0)
Post	273***	197***	503.8***	735.4***
	(16.5)	(15.6)	(22.6)	(56.2)
Age		1.95***	2.0***	0.2
		(0.22)	(0.2)	(0.2)
Time in program		23.9***	23.0***	30.2***
		(0.27)	(0.3)	(2.1)
Constant	242***	121***	−167.7***	−179.1***
	(15.4)	(15.8)	(722.1)	(39.4)
Month–year dummies	No	No	Yes	Yes
Implied interest rate elasticity of borrowing	−0.40	−0.68	−0.91	−0.71
Pre-treatment mean dependent variable	329	329	329	651
Post-treatment mean dependent variable	515	515	515	1093
Observations	68,037	68,037	68,037	25,926
R^2	0.020	0.12	0.13	0.24

Notes: Column 1 estimates the difference-in-difference specification in Eq. (1), $y_{it} = \beta_0 + \beta_1\ Treatment_i + \beta_2\ Post_t + \beta_3\ Treatment_i \times Post_t + \varepsilon_{it}$, where "Treatment" is a dummy indicating clients at the treatment branches of Tikkapara and Kalyanpur, "Post" is a dummy variable taking the value of 1 after February 2000 (i.e., after loan interest rates were hiked at Tikkapara and Kalyanpur branches), and "Treatment × Post", the main variable of interest, is the interaction of these two terms. In column 2, we add the additional controls age (the age of the client in years) and time in program (the length of time the accountholder has been with *Safe*Save). In columns 3 and 4 we add month–year dummies. The full sample includes all 60,506 monthly observations of clients at all three branches — Tikkapara, Kalyanpur and Geneva, over the period of our study, January 1999–January 2001. The balanced sample used in column 4 includes only 25,926 monthly observations of clients that were in the sample both before and after the interest rate increase at the Tikkapara and Kalyanpur branches in February 2000. The implied interest rate elasticity of borrowing shows the percentage reduction in loans we would expect to find from a 1% reduction in interest rates based on parameter estimates. Standard errors clustered by month appear in parentheses. ** indicates significance at 5%; *** indicates significance at 1%.

growth between branches in the pre-treatment period, but the coefficient on the triple interaction of a treatment group indicator, a post-time-period indicator, and a time trend shows that loan balances at Tikkapara and Kalyanpur, the treatment group, undergo a significant decline in trend growth in the post-treatment period (after January 2000). In column 4, we see that when age and time in program are included as controls there is no significant pre-period difference, in either trend or level, between the treatment and comparison branches, but we still see the significant decline in trend growth in the post-treatment period for the treatment group, clients at the Tikkapara and Kalyanpur branches.

6.2. Difference-in-difference estimator

The difference-in-difference estimator of Eq. (1), above, uses behavior in the Geneva branch to estimate and subtract off the underlying time trend from Tikkapara and Kalyanpur. The net impact of the interest rate increase (Table 3, column 1) is a 93 taka reduction in loan demand. The impact is relatively small (the implied elasticity is −0.40) and, given the large sample size, highly statistically significant.

The interest rate elasticity rises in absolute value (to −0.68) once customer age and their time with *Safe*Save are included as controls in the second column. The third column increases the flexibility of the specification by allowing for a full set of month–year dummy variables. The ability to better control for underlying trends lowers the interest rate elasticity further to −0.91.

The fourth column of Table 3 restricts the analysis to a balanced sample; observations are kept only if customers are in the sample both six months before and after the price change. The number of observations thus falls from 68,037 to 25,926. The pattern of results is robust in this smaller sample, and the interest rate elasticity (−0.71) remains in a similar range.

6.3. Individual fixed effects and robustness checks

Although individual-level controls are not required with the difference in differences strategy, the inclusion of controls, for example, for heterogeneity in customer tastes and constraints, would allow for an indirect test of the identification strategy, while relaxing the identifying assumptions. Although age, gender, and time in program are the only individual controls available in our data, because of the lengthy panel, we are able to estimate individual fixed effects. Results are presented in Table 4. In column 1 of Table 4 we find that individual fixed effects absorb a significant amount of variation (the R-squared increases from 0.13 to 0.69) and take the interest rate elasticity to −0.77. The fact that this is close to our estimate in Table 3, column 4 (−0.71), lends credence to our identification strategy. We take the results reported in column 1 of Table 4 as our baseline estimate, and proceed to a series of robustness checks.

The panel used above is not balanced: customers enter the program at different points and some exit before January 2001. So a potential concern is that the changing mix of customers over time affects the results. In column 2, we keep the individual fixed effects and month–year time dummies while also restricting the sample to a balanced panel made up of customers who were participating in the program at least six months before and after the February 2000 interest rate increase. The estimates from the balanced panel yield similar results to column 1, with an interest rate elasticity of −0.73.

The third column allows trends in Tikkapara and Kalyanpur to differ from Geneva's base trend both before and after the interest rate change (we retain the differential intercepts of the standard difference-in-difference model, in addition to account fixed effects). The treatment effect in this model is both the shift in the intercept and the differential trend associated with being in Tikkapara or Kalyanpur in the months after the interest rate increase. The average elasticity in this specification is −0.73, again similar to column 1.

Table 4
Interest rate effects on loan balances — individual fixed effects.

	(1)	(2)	(3)	(4)
Sample	Full sample	Balanced sample	Full sample	Full sample
Specification	Panel with fixed effects	Panel with fixed effects	Panel with fixed effects	Panel with fixed effects
Dependent variable	Monthly loan balances	Monthly loan balances	Monthly loan balances	Log of monthly loan balances: log(loan balances + 1)
Treatment × Post	−388.5***	−366.5***	−207.9	−2.4***
	(11.8)	(45.2)	(158.3)	(0.28)
Treatment × Post × Trend			−28.8***	
			(8.4)	
Treatment × Trend			−2.5	
			(22.1)	
Post × Trend			9.2	
			(8.9)	
Trend			6.9	
			(19.0)	
Age	−1.1	−25.3***	−3.2	−0.21***
	(9.3)	(2.5)	(28.1)	(0.013)
Time in program	54.0***	73.3***	37.2***	0.30***
	(1.0)	(2.3)	(4.1)	(0.014)
Constant	−94.6	−81.8	40.1	5.4***
	(245.1)	(408.7)	(697.2)	(0.33)
Implied interest rate elasticity of borrowing	−0.77	−0.73	−0.73	−0.74
Pre-treatment mean dependent variable	329	651	651	4.55
Post-treatment mean dependent variable	515	1093	1093	6.31
Observations	68,037	25,926	68,037	68,037
R^2	0.69	0.62	0.69	0.68

Notes: All specifications include month–year dummies and individual (account) fixed effects. In columns 1, 2, and 4 we estimate a difference-in-differences specification with month–year fixed effects, account fixed effects, and additional controls as indicated, where variables are defined as in Table 3. In column 3 we also include a linear time trend and the double and triple interactions of a treatment indicator, a post period indicator, and the time trend as indicated. The full sample includes all 60,506 monthly observations of clients at all three branches — Tikkapara, Kalyanpur and Geneva, over the period of our study, January 1999–January 2001. The balanced sample used in column 2 includes only 25,926 monthly observations of clients that were in the sample both before and after the interest rate increase at the Tikkapara and Kalyanpur branches in February 2000. The implied interest rate elasticity of borrowing shows the percentage reduction in loans we would expect to find from a 1% reduction in interest rates based on parameter estimates. Standard errors clustered by month appear in parentheses. ** indicates significance at 5%; *** indicates significance at 1%.

Column 4 illustrates that the results are robust to moving to a logarithmic specification. When the dependent variable is the logarithm of (1 + loan balances), the specification yields an estimated interest rate elasticity of −0.74, again similar to that of our baseline estimation in column 1.

6.4. Heterogeneous effects

Table 5 examines the heterogeneity of our main result along two dimensions: estimation window and the borrowing capacity of individual customers. We have also explored possible differences in responsiveness by gender and age (in results not reported here), but do not find substantial differences in estimated elasticities.

6.4.1. Narrower estimation window

In our main results, we include the period 12 months before and 12 months after the announcement of the change in interest rates. One concern is that our results could be driven by events late in the sample window, unrelated to changes in the interest rate. Thus in Table 5, columns 1 and 2, we narrow the window to nine months pre and nine months post (an 18 month total window) and to three months pre and three months post (a six month total window). With a nine month estimation window, the estimated elasticity is −0.76, similar to our baseline estimate reported in column 1 of Table 4. Looking at only three months before and after the policy change, the narrowest window, the estimated responsiveness is smaller, at −0.39, but still negative and statistically significant at standard levels. The lower elasticity in the 3-month window is consistent with Fig. 2, which suggests that households continue to adjust loan balances for up to 12 months after the interest rate increase.

6.4.2. Borrowing capacity

Table 4 presented a range of estimates of the change in loan balances in response to changes in the interest rate. Though these estimates account for time trends and time effects more flexibly, as well as observed and unobserved individual characteristics, the estimates do not account for variation in borrowing capacity. In particular, individuals with low borrowing capacity are less able to respond to changes in interest rates than individuals with higher capacity (this is most transparent for individuals with zero borrowing capacity). In columns 3 and 4 of Table 5 we address this by taking advantage of our knowledge of the exact rules used by *Safe*Save to determine the maximum loan capacity of borrowers (the rules are detailed in Appendix A).

Column 3 introduces capacity as a control in our main specification. The estimated interest-rate responsiveness and elasticity are somewhat greater than our baseline result, −0.88 compared to −0.77. The coefficient on capacity is 0.2, which suggests that households increase their borrowing by only 20% of an increase in borrowing capacity.

However, simultaneity and omitted variable bias with respect to the capacity measure are serious concerns. Simultaneity bias is a serious concern since a common shock could drive both savings (which is the most important component of capacity) and borrowing. In particular, the presumption is that a negative shock would decrease savings and increase the demand for loans, potentially biasing the elasticity estimates downward. Second, borrowing capacity is determined mostly by savings, which could affect the demand for loans for reasons other than borrowing capacity.

We address these concerns by instrumenting for loan capacity using the length of time the individual has been with *Safe*Save. As discussed in Section 5, time in program plausibly satisfies the key requirements for a valid instrumental variable. Results are presented in column 4. We note that the F-statistic of the instrument in the first stage is reasonably high (10.75). The estimated effect of interest rates on borrowing increases in absolute value. The implied interest rate elasticity is now −1.04, the most responsive change in loan demand that we find in any specification.

Table 5
Interest rate effects on loan balances — exploring heterogeneous effects.

	(1)	(2)	(3)	(4)
Type of heterogeneity	Estimation window		Borrowing capacity	
Sample	Nine month pre/post treatment window	Three month pre/post treatment window	Full sample	Full sample
Specification	Panel with Fixed Effects	Panel with Fixed Effects	Panel with Fixed Effects	Panel with Fixed Effects using Instrumental Variable
Dependent variable	Monthly loan balances	Monthly loan balances	Monthly loan balances	Monthly loan balances
Treatment × Post	−379.4***	−198.1***	−469.5***	−523.5***
	(45.5)	(11.8)	(9.9)	(36.9)
Time in program	58.8***	64.1***	35.7***	
	(3.8)	(2.1)	(0.8)	
Borrowing capacity			0.2***	0.39***
			(0.001)	(0.03)
Implied interest rate elasticity of borrowing	−0.76	−0.39	−0.88	−1.04
F-stat in instrument				36.55
Pre-treatment mean dependent variable	741	436	651	651
Post-treatment mean dependent variable	1073	1047	1093	1093
Observations	54,977	19,719	68,037	68,037
R^2	0.74	0.87	0.78	0.37

Notes: In all columns we estimate a difference-in-differences specification with month–year fixed effects, account fixed effects, and controls for age and time in program, where variables are defined as in Table 3. In column 2, age drops out as a control because it is collinear with time in program, given the narrower time window (6 months) and inclusion of individual (account) fixed effects. In column 3, we also control for borrowing capacity, which is our calculation of the maximum amount clients would be eligible to borrow under *Safe*Save rules (detailed in Appendix A). In column 4, we instrument for borrowing capacity using time in program. In column 1 (column 2) we consider the sub-samples of observations in a nine (three) month window around the interest rate increase. Thus, in column 1, the 9-month pre/post treatment window includes client observations from April 1999 to October 2000. In column 2, the 3-month pre/post treatment window, includes client observations from October 1999 to May 2000. The full sample (columns 3 and 4) includes all 60,506 monthly observations of clients at all three branches — Tikkapara, Kalyanpur and Geneva, over the period of our study, January 1999 to January 2001, which is 12 months before and after the interest rate change in the Tikkapara and Kalyanpur branches in February 2000. The implied interest rate elasticity of borrowing shows the percentage reduction in loans we would expect to find from a 1% reduction in interest rates based on parameter estimates. Standard errors clustered by month appear in parentheses. ** indicates significance at 5%; *** indicates significance at 1%.

Table 6
Mechanisms for interest rate effects.

	(1)	(2)	(3)	(4)	(5)	(6)
Sample	Full sample	Clients who took a loan during the sample period	Clients who took a loan during the sample period	Clients who repaid part of an outstanding loan during the sample period	Clients who made a withdrawal from savings during the sample period	Clients who made a deposit to their saving account during the sample period
Specification	Panel with fixed effects (linear probability model)	Panel with fixed effects	Panel with fixed effects	Panel with fixed effects	Panel with fixed effects	Panel with fixed effects
Dependent variable	Takes a loan (=1 if yes)	Amount borrowed	Length of loan cycle	Amount repaid	Amount withdrawn from savings	Amount of savings deposited
Treatment × Post	0.049***	−202.0***	−9.95***	103.4***	34.2*	−4.59
	(0.025)	(58.4)	(1.53)	(17.2)	(15.4)	(3.44)
Time in program	0.002**	82.7***	1.25***	4.6***	7.01***	−1.29***
	(0.001)	(7.3)	(0.25)	(0.9)	(0.84)	(0.14)
Implied interest rate elasticity	1.08	−0.33	−1.55	1.51	0.42	−0.18
Pre-treatment mean dependent variable	0.085	1196	11.1	161	136	58.4
Post-treatment mean dependent variable	0.096	1173	10.4	163	133	70.9
Observations	68,037	6240	6240	30,479	14,625	49,386
R^2	0.14	0.85	0.57	0.22	0.56	0.35

Notes: In all columns we estimate a difference-in-differences specification with month–year fixed effects, account fixed effects, and controls for age and time in program, where variables are defined as in Table 3. In column 1 the dependent variable is an indicator if the accountholder takes a loan in that month (1 if yes, 0 otherwise); thus, we estimate a linear probability model. In columns 2 to 6, the dependent variables are: column 2, the amount borrowed for each loan (6240 loans in total): column 3, months elapsed between taking a loan and fully repaying it (length of loan cycle, observed for each loan); column 4, the amount repaid each month (when loan balances are positive); column 5, the amount withdrawn from savings each month (positive withdrawals only, excluding zeros); and column 6, the amount deposited to savings (positive deposits only, excluding zeros). The full sample includes all monthly observations of clients at all three branches — Tikkapara, Kalyanpur and Geneva, over the period of our study, January 1999 to January 2001. The implied interest rate elasticity of borrowing shows the percentage reduction in loans we would expect to find from a 1% reduction in interest rates based on parameter estimates. Standard errors clustered by month appear in parentheses. * indicates significance at 10%; ** at 5%; and *** at 1%.

6.5. Other outcomes and mechanisms

In Table 6, we examine the impact of the interest rate increase on a range of other outcomes – the probability of taking a loan, the amount borrowed, and the speed of repayment – using our baseline specification which incorporates individual fixed effects and month–year time dummies.

In column 1 we examine the probability that a borrower takes a loan in a given month, and find a five percentage point increase in the probability of taking a loan after the interest rate increase. If borrowers are taking more loans, but average loan balances are decreasing, it suggests either that the size of loans is decreasing or that repayment rates are accelerating.

Columns 2, 3, and 4 show that both mechanisms are present. In column 2, we find that the amount borrowed with each loan decreases by about 200 Taka, or 17% relative to the typical loan size. Column 3 illustrates that the length of the average loan cycle (the time between taking a loan and the next one) in the treatment group fell by about ten months relative to the comparison group. For the amount repaid (column 4), we find an increase of approximately 100 taka, or 60% relative to the typical monthly repayment. Taken together, these results suggest that the interest rate increase induced borrowers to take more frequent, smaller loans and to repay them more quickly than before. This behavior is consistent with a Baumol–Tobin style view of loan balances. If individuals use borrowing to meet a constant outflow throughout the month, then an interest rate increase will lead to lower balances and more frequent withdrawals.

The fifth column shows that, as expected, withdrawals from savings accounts rise, to compensate for the decrease in borrowing. Deposits also fall, as reported in column 6, but the coefficient is small and not statistically significant.

6.6. Longer-run effects

Our results thus far show borrowing patterns in Tikkapara and Kalyanpur consistent with significant responses to the increased interest rate. However, this raises the question of whether these two branches will eventually converge to a borrowing pattern similar to Geneva, where loans were being made at the higher interest rate throughout. As we saw in Fig. 2, all three branches exhibited the same upward trend growth in loan balances in the pre-treatment period, suggesting that Geneva branch is a reasonable comparison branch for Tikkapara and Kalyanpur. If Geneva branch is indeed a good comparison for Tikkapara and Kalyanpur, then eventually we would expect to see the three branches converging to a similar steady state growth path. We examine this in Table 7 where we compare

Table 7
Long run effects of interest rates on loan balances.

	(1)	(2)	(3)
Sample	All accounts, 1 year or more after treatment	Clients who took out a new loan, 1 year or more after treatment	Clients who took out a new loan, 1 year or more after treatment
Specification	OLS	OLS	OLS
Dependent variable	Monthly loan balances	Amount borrowed	Length of loan cycle
Treatment	−201.9***	−2.6	−0.35
	(22.6)	(26.7)	(0.52)
Observations	120,358	6206	6206
R^2	0.15	0.34	0.10

Notes: In all columns, we estimate the (cross-sectional) difference in the dependent variable between the treatment and comparison branches, controlling for month–year dummies, age, and time in program, as defined in Table 3. The dependent variables are: in column 1, monthly loan balances; in column 2, amount borrowed for each loan; and in column 3, months elapsed between taking a loan and fully repaying it (length of loan cycle, observed for each loan). To enable us to examine long-run changes or convergence, the sample here is clients at all three branches 12 to 48 months *after* treatment, so from January 2001 to April 2004. The implied interest rate elasticity of borrowing shows the percentage reduction in loans we would expect to find from a 1% reduction in interest rates based on parameter estimates. Standard errors clustered by month appear in parentheses. ** indicates significance at 5%; *** indicates significance at 1%.

borrowing in Tikkapara and Kalyanpur to Geneva in the period 12 to 48 months after the interest rate change (January 2001–April 2004). Note that these specifications cannot control for account fixed effects, as this would absorb the treatment dummy, but they do include controls for the length of time the borrower has been with *Safe*Save and age.

Column 1 shows that loan balances remain lower in Tikkapara and Kalyanpur than Geneva, but the magnitude of the difference (approximately 200 taka) is about half of that in our reference specification. It must be borne in mind that many borrowers continue to turn over their loans, and thus reduced loan balances in response to the increased interest rate could persist for a number of years.

To gain a clearer sense of differences between the two sets of branches, we then compared the loan amount and the length of the loan cycle for new loans made after January 2001. As reported in columns 2 and 3 of Table 7, in the long term, we find no significant difference in either loan size or length of loan cycle between new loans made at Geneva or new loans made at Tikkapara and Kalyanpur. Although existing borrowers continue to exhibit differences in average loan balances even several years after the interest rate increase, the behavior of new borrowers begins to look similar. This suggests that once the treatment group of borrowers at Tikkapara and Kalyanpur have adjusted to the higher interest rate, their trend growth in loan balances is likely to converge to that of Geneva borrowers.

6.7. Profit

*Safe*Save's decision to raise the interest rate was driven by the perceived need to cover costs and attain profitability. Our findings thus far suggest that this goal was achieved to some extent. An overall loan balance elasticity of close to, but less than, −1 in Table 4 (column 1) suggests that interest income should increase somewhat with the interest rate increase. So as long as costs are not increasing significantly, profits should increase. Table 8 shows that this is true, but with two interesting qualifications.

The first two columns of Table 8 analyze balance sheet data from *Safe*Save. The average monthly loss, averaged across the three branches in the year before the interest hike, was −18,499 taka; the average monthly loss was reduced to −1237 taka in the year after the hike. As predicted, the regression coefficient on the treatment-post period interaction in column 1 is positive, showing that 6783 taka, or about one-third of the improvement, can be attributed to the interest rate change, although the result is not statistically significant (unsurprising, given the sample size).

Column 2 turns to average profits per client per month, which improves from −147 taka in the year before the hike to −8.94 taka in the year after. Here, the coefficient on the time effect shows that there was a general trend toward profitability per client in Tikkapara and Kalyanpur, but the coefficient on the treatment effect (treatment × post) shows that, on net, the interest rate hike served to reduce profitability per client in the year after the change. In conjunction with the result in column 1 this suggests that there is significant heterogeneity in the effect of the interest rate increase on profitability per client, i.e., that profits increased for some clients but not others. In order to dig more deeply into this finding, we turn to account-level data aggregated to the branch level in columns 3 to 10. Account-level data have the advantage that we can split the sample to look at new accounts versus longstanding accounts, but also the limitation that we observe only one dimension of costs at the individual level (namely loan losses). We find that average monthly interest income per branch increased from 13,534 taka in the year preceding the hike to 28,854 in the year after (column 3). Similarly, interest income per client per month increased from 9.2 taka to 16.4 taka (column 4). Turning to the effect of the interest rate increase, the treatment effect in column 3 is

Table 8
Interest rate effects on interest income, loan losses, and profit.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Sample	Full sample	Full sample	Full sample	Full sample	Full sample	Long-term accounts	Long-term accounts	New accounts	New accounts	Long-term excluding top 10% of borrowers
Data source	Monthly branch balance sheet data	Monthly branch balance sheet data	Client data aggregated to branch level	Client data aggregated to branch level	Client data aggregated to branch level	Client data aggregated to branch level	Client data aggregated to branch level	Client data aggregated to branch level	Client data aggregated to branch level	Client data aggregated to branch level
Specification	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS
Dependent variable	Profit per branch	Average profits per client	Interest income per branch	Interest income per client	Value of loan write-offs per branch	Interest income per branch	Value of loan write-offs per branch	Interest income per branch	Value of loan write-offs per branch	Interest income per branch
Treatment × Post	6783	−251***	−960	−7.0**	3741.5**	4396*	2555**	−5356	1186*	−2263**
	(28,020)	(74)	(5435)	(2.7)	(1439.3)	(2155)	(917)	(3558)	(674)	(1059)
Treatment	3669	267***	23,749***	6.5***	0.0	14,062***	0	9687***	0	10,633***
	(22,046)	(72)	(4086)	(2.1)	(1082.1)	(1620)	(689)	(2675)	(507)	(796)
Post	−29,560	272***	26,780**	14.8***	2043.9	3053	2637	23,727***	−593	88
	(58,966)	(83)	(9532)	(4.8)	(2524.3)	(3780)	(1608)	(6240)	(1183)	(1857)
Constant	−65,672	−296***	2398	7.6**	0.0	1348	−0	1050	−0	1380
	(49,297)	(78)	(6776)	(3.4)	(1794.4)	(2687)	(1143)	(4436)	(841)	(1320)
Pre-treatment mean dep. var.	−18,499	−147.3	13,534	9.236	0	8113	0	5421	0	6196
Post-treatment mean dep. var.	−1237	−8.94	28,854	16.41	2027	12,017	1384	16,837	642.6	6010
Observations	46	44	47	47	47	47	47	47	47	47
R^2	0.54	0.60	0.85	0.72	0.674	0.93	0.690	0.79	0.598	0.94

Notes: In all columns we estimate a difference-in-differences specification with month–year fixed effects, where variables are defined as in Table 3. The full sample refers to all branch data (for columns 1 and 2) or data for all clients aggregated to the branch level (for columns 3 to 10).For this exercise the treatment branches of Tikkapara and Kalyanpur are combined into a single treatment branch and compared to Geneva over the period of study, January 1999 to January 2001. In columns 6 and 7, the sample of long-term accounts used to construct branch aggregates includes only those clients who were present in the sample both before and after the interest rate increase at the Tikkapara and Kalyanpur branches in February 2000 (i.e., the balanced sample used above in Table 3, column 4). In columns 8 and 9, the sample of new accounts used in generating the results is the complement of long-term accounts sample in columns 6 and 7, and includes clients who joined just before or after the interest rate hike and older clients who dropped out just before the interest rate hike. In column 10, we use the same sample as columns 6 and 7, but exclude the top 10% borrowers (as measured by interest payments). Standard errors in parentheses. * indicates significance at 10%; ** at 5%; and *** at 1%.

small, negative, and not statistically significant. This is not inconsistent with our result in column 1 (the treatment effect in column 1 is within 1.5 standard errors of the treatment effect in column 3), but nor does it account for the increase in profits at the branch level. Likewise, in column 4, when the dependent variable is interest income per client, the effect is relatively large, negative, and statistically significant, explaining half of the overall change and consistent with column 2. In column 5, we examine the impact of the interest rate increase on the value of loans that have been written off as non-performing, and amplifying the results of columns 2 to 4, we find that not only does interest income decrease but also the value of loan write-offs increases.

In hopes of reconciling our finding that branch-level profits increase while profits per client decrease, in column 6 we examine the effect of the interest rate increase on interest income per branch in the balanced panel (the sample of accountholders who were present both before and after the interest rate increase, also used in Table 3, column 4). We find that – consistent with column 1 – the interest rate hike *increased* income per branch from long-term accountholders by 4396 taka (an effect which is significant at the 10% level). In column 7, we find that the impact of the interest rate increase on loan write-offs in the balanced panel is positive and significant at the 5% level, but the increase in loan losses is approximately half the magnitude of the increase in interest income. Taken together, this is consistent with the increase in profits observed in column 1, and contrasts with the reduction in profits reported in columns 3 to 5. The difference in results suggests that profits increased on long-term borrowers but decreased on new customers who joined *Safe*Save after the price hike.

Columns 8 and 9 confirm this interpretation. When the sample includes only new and short-term clients, the interest rate increase leads to reduced interest income (−5356 taka, not statistically significant) and increased loan write-offs (1186 taka, significant at the 10% level). Finally, column 10 underscores the heterogeneity of the treatment effect by trimming the top ten percent of borrowers from the balanced sample. The treatment now has a negative impact (with a coefficient of -2263 taka), suggesting that the increase in income from the price hike in column 6 is driven by increased earnings from larger-scale customers, whereas there was a decrease in income from smaller-scale customers and new borrowers.

7. Conclusion

It has been argued that microlenders can achieve the goal of financial sustainability by increasing interest rates, in the hopes of achieving profitability. Once profitable, microlenders can expand as far as the market will allow, without concern for the availability of funds from donors. The natural fear, though, is that raising interest rates too high will erode surpluses generated by customers and reduce the demand for financial services, undermining the original intention of the push for microfinance. We have examined the widely held view that poor customers are in fact apt to be insensitive to interest rates and have ample surpluses with which to pay cost-covering fees using evidence from an unexpected price change at *Safe*Save, a microfinance organization operating within the slums of Dhaka.

Using between-branch variation in interest rates we estimate loan elasticities in the range of −0.73 to −1.04, with our preferred short-run estimate being at the upper end of this range. *Safe*Save did, importantly, achieve financial stability as a result of the interest rate increase: interest income grew and losses were cut. Our results show that clients took full advantage of *Safe*Save's flexible lending policy, taking smaller and more frequent loans and repaying them more quickly. It is worth noting that the response to an interest rate increase of borrowers from other microlenders not offering similarly flexible conditions might be quite different. They could for example opt out of borrowing altogether if they are unable to adjust the size and term of their loan. Or, conversely, borrowers might accede to the constraints and simply absorb the higher cost.

One important question, which our data have not allowed us to investigate with sufficient confidence, is whether there were differences in the impact of the interest rate increase on customers of different income and wealth. But we are able to demonstrate conclusively that the gains came disproportionately from the largest-scale customers. The fall in demand for loans was associated with decreases in interest income earned from smaller-scale and newer customers. Thus, this study shows one way that increases in price generate important demand responses, and it highlights heterogeneous impacts on customers.

Appendix A

A.1. SafeSave product rules[19]

A.1.1. Product P2

Offered in Tikkapara and Kalyanpur branches as of November 1997. Not changed (except for the February 2000 interest rate rise on loans) until August 2003.

Eligibility: Anyone in the slum including children (children are allowed to borrow); multiple accounts per person allowed and per household are allowed.

Account Fees: no account opening, closing, or monthly fees.

Savings: Deposit any sum at any time; withdraw any sum at any time unless a loan is held in which case no withdrawal is allowed; interest is paid in two ways (a) if the account was held for 5 years, then 25% of the final balance is paid at the end of the term (provided certain safeguards against 'end loading' were satisfied) (b) if the account is closed before 5 years interest paid retrospectively at closure at 1% a month for accounts that attained and maintained a 1000 taka balance.

Loans: Account must be 2 months old and savings must have reached 500 taka before first loan; first loan = savings balance + 1000 taka, subsequent loans savings balance + 1500 taka, then savings balance + 2000 taka, etc., no limit; a disbursement fee of 100 taka for loans up to 5000 taka, 200 taka for bigger ones; interest charged monthly at 2% per month on outstanding balance at end of previous month; no fixed repayment schedule and no fixed term but a 'renewal fee' equal to the disbursement fee payable each 6 months.

In February 2000, the interest rate on loans was raised from 2% to 3% per month; renewal fees set at 3% of outstanding balance (rather than as a set figure).

Insurance: None.

A.1.2. Product P3

Only offered in Geneva branch. Introduced in March 1999 and not changed until August 2003.

Eligibility: Anyone in the slum including children (children are allowed to borrow); multiple accounts per person allowed and per household are allowed.

Account Fees: no account opening or closing fees, 10 taka monthly service fee.

Savings: Two products: current and long-term, both optional.

Current Savings: deposit any sum at any time; withdraw any sum at any time; no linkage with loans; interest paid on balances of 500 taka

[19] These rules were written by Stuart Rutherford. Kalyanpur was originally served by the Tikkapara branch and became its own branch in September 1998. The product rules were unchanged during the switch.

or more at 1% a month but no interest in months when withdrawals are made.

Long-term savings: a 60-month accumulating savings device, monthly deposits 50 taka or a multiple of 50; if terminated prematurely no interest is paid; after 60 months the client stops saving and interest is added at the same monthly deposit rate, so the longer the client holds the savings the more s/he receives and the higher the effective rate.

Loans: Client must have held and paid into a long-term savings account for 2 months before a loan can be taken, and must be up-to-date with long-term savings to borrow; the first loan value is 1000 taka then rises in 1000 taka steps; maximum value cannot exceed the monthly long-term deposit × 100. Repay any time, any schedule; charge of 3% of loan when it is disbursed; interest paid monthly at 3% of previous month-end balance.

Insurance: None.

A.2. Comparison

Products P2 and P3 are similar, aside from two differences. The first is the interest rate, was initially 2% in P2 and was eventually increased to 3%, thereby matching the interest rate in P3. The second difference is that P3 differentiates long-term and current savings, with lending based on the former. Our differences-in-differences strategy assumes that the differences in savings rules between P2 and P3 did not lead to a differential trend in borrowing between treatment and comparison branches. This is corroborated by Fig. 2 and our statistical tests in Table 2.

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