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Deposit insurance and bank risk-taking: Evidence from internal loan ratings

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ABSTRACT

We analyze the effect of deposit insurance on the risk-taking behavior of banks in the context of a quasi-natural experiment using detailed credit registry data. Using the case of an emerging economy, Bolivia, which introduced a deposit insurance system during the sample period, we compare the risk-taking behavior of banks before and after the introduction of this system. We find that in the post-deposit insurance period, banks are more likely to initiate riskier loans (i.e., loans with worse internal ratings at origination). These loans carry higher interest rates and are associated with worse ex-post performance (i.e., they have higher default and delinquency rates). Banks do not seem to compensate for the extra risk by increasing collateral requirements or decreasing loan maturities. We also find evidence that the increase in risk-taking is due to the decrease in market discipline from large depositors. Finally, differences between large (too-big-to-fail) and small banks diminished in the post-deposit insurance period.

1. Introduction

We investigate the effect of deposit insurance on the risk-taking behavior of banks in the context of a quasi-natural experiment using detailed credit registry data, which allow us to identify the effect of deposit insurance on contemporaneous and ex-ante risk-taking.

Using the case of Bolivia, an emerging economy that introduced a deposit insurance system in December 2001, we compare the risk-taking behavior of banks before and after the introduction of this system. The comparison is between ambiguous implicit guarantees and explicit deposit insurance,

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with flat insurance premiums and partial coverage for all depositors. The introduction of explicit deposit insurance was part of the country's efforts to conform to the blueprints of international financial architecture—as many developing countries and emerging markets have done in recent years.[1] Bolivia provides a good case study, since the introduction of the system did not coincide with other regulatory changes.

We employ a unique database with detailed information (including internal credit ratings, contract features, and ex-post performance) on the population of loans granted by any bank operating in the country between 1999 and 2003. The analysis focuses on loan initiations ("fresh loans") and internal credit ratings at origination to measure risk-taking. In other words, we examine whether after the introduction of deposit insurance, banks are more likely to initiate loans to borrowers *they know* are riskier.[2] We also examine whether they adjust other contract terms, such as collateral and maturity, to compensate for any increase in risk. This is the first paper that employs such disaggregated and detailed data to investigate changes in the credit policy of banks following the introduction of an explicit government guarantee.

Due to data limitations, many of the existing studies evaluate risk-taking by examining bank failures or non-performing loans. Both measures have several shortcomings. Not only are they ex-post measures of risk (i.e., low-risk loans at origination could default later on if economic conditions deteriorate), but they are also backward-looking, making it difficult to uncover the effect of deposit insurance on risk-taking, especially since most deposit insurance systems are introduced or modified at the onset of, or in response, to a financial crisis.[3]

Controlling for changes in macroeconomic conditions and competition in the local loan markets, we find that after the introduction of deposit insurance banks are more likely to initiate riskier loans (loans with ratings higher than one, which is the best rating). As expected, these loans carry higher contractual interest rates and are more likely to entail overdue payments or default than loans with the best rating. Our results also suggest that banks do not increase collateral requirements or decrease loan maturity to compensate for the extra risk.

Apart from analyzing banks' decisions on credit quality before and after the introduction of deposit insurance, we also examine how different bank characteristics affect those decisions. Prior to the introduction of this system, banks with a high share of large depositors take less risk, but the effect disappears after the introduction of a system that provided all depositors with generous explicit guarantees. This result mirrors the evidence in de Dreu and Ioannidou (2006), which shows that large depositors in Bolivia discipline their banks prior to, but not after, the introduction of deposit insurance. Our results also show that the banks that benefited the most from the explicit guarantee (i.e., those that experienced the largest drop in the cost of deposits following the introduction of deposit insurance) are the ones that take more risk in the second period. Finally, before the introduction of deposit insurance, very large banks (those more likely to enjoy 'too-big-to-fail' guarantees) take more risk than small banks do. As expected, this differential effect disappears when all banks are subject to explicit deposit insurance. This cross-sectional analysis not only strengthens our identification, but also provides direct empirical evidence of the specific channels through which deposit insurance influences the incentives of banks to take additional risk.

Although the existing empirical evidence is mixed, most of the studies find that deposit insurance increases the risk-taking behavior of banks (or at least provide evidence consistent with this interpretation). For example, Alston et al. (1994), Grossman (1992), Wheelock (1992), and Wheelock and Wilson (1995) find a positive relationship between US bank failure rates in the 1920s and 1930s and deposit insurance. Using option pricing models, Hovakimian and Kane (2000) find that risk-based capital requirements did not prevent large US banks—especially poorly capitalized banks and those with high ratios of deposits to total debt—from shifting risk onto the safety net.[4] In contrast, Karels and McClatchey (1999) find that the adoption of deposit insurance in

[1] See Demirgüç-Kunt et al. (2008), for recent trends in deposit-insurance adoption.

[2] Changes in loan quality are likely to capture the bulk of bank risk-taking in this case, since Bolivian banks are relatively small and unsophisticated, with few off-balance-sheet activities.

[3] See, for example, the discussion in Gropp and Vesala (2004) and Grossman (1992).

[4] This study builds on Markus and Shaked (1984), Ronn and Verma (1986), and Pennacchi (1987a,b).

the 1970s decreased the risk-taking of US credit unions (e.g., they had lower ratios of non-performing loans after deposit insurance).

More recent papers examine how the design of the deposit insurance scheme and the institutional framework influence the effect that deposit insurance has on the risk-taking behavior of banks. Using a sample of more than 60 developed and developing countries Demigurc-Kunt and Detragiache (2002) find that deposit insurance increases the probability of a banking crisis, especially in countries with weak institutional environments. Applying the option pricing model in a cross-country sample, Hovakimian et al. (2003) find that the introduction of deposit insurance systems (as opposed to implicit guarantees) has had adverse effects in countries with low levels of political and economic freedom and high levels of corruption. They also find that risk-shifting is attenuated by risk-sensitive premiums, coverage limits, and coinsurance. Gropp and Vesala (2004), on the other hand, find that the introduction of explicit deposit insurance in Europe reduced bank risk-taking. They argue that explicit deposit insurance may have implied a de facto reduction in the scope of the safety net by credibly excluding large subordinate debt holders from the previously implicit guarantees.[5]

This paper is organized as follows. Section 2 explains the institutional background and describes the Bolivian deposit insurance scheme compared to other countries. Data are described in Section 3, while the methodology is presented in Section 4. Section 5 reports the results. Robustness checks are presented in Section 6. Section 7 concludes.

2. Institutional background

Bolivia introduced explicit deposit insurance on December 20, 2001 with the passage of Law 2297. Before then, there were some ambiguous implicit guarantees. For example, when Banco Sur and Banco de Cochabamba failed in 1994, the Bolivian Central Bank (BCB) covered 100% of their deposits to the private sector. In more recent years, these bailout policies have tended to favor small depositors, and in some cases it took a long time for funds to be paid back.[6] Hence, it would be reasonable to argue that prior to the introduction of deposit insurance, large depositors had incentives to discipline their banks.

In terms of its characteristics, the Bolivian deposit insurance system resembles its counterparts in the rest of the world. Participation is mandatory. There is a permanent fund, financed by insurance premiums. If the fund's resources are not enough to cover the insured amount, then the BCB is required to provide the lacking resources, lending credibility to the newly established fund.[7] The insurance premiums are not risk-based, but simply proportional to the bank's private-sector deposits. Similar to most deposit insurance systems, interbank deposits are not insured, and deposits in the local or foreign currency are treated equally.[8]

The only difference with respect to most deposit insurance systems is the absence of full insurance up to a certain amount per depositor/account.[9] The coverage rate does not vary among accounts of different size within a given bank (as in the United States), but it varies across banks and time, depending on their liabilities structure. Specifically, the fund insures only up to 50% of a bank's "total preferred obligations", which are divided into senior and subordinate obligations. Senior obligations consist primarily of deposits to the private sector, while subordinate obligations include obligations to the public sector, the BCB, and foreign financial entities. Hence, banks with a larger share of deposits to total (preferred) liabilities are insured at a lower rate (i.e., there is a trade-off between the volume and the rate at which funds are insured). All banks, however, have a liability structure that implies that only private-sector

[5] Before the introduction of explicit deposit insurance some European countries may have been characterized by strong implicit insurance through the expectations of public intervention at times of distress (e.g., during the Swedish and Finnish banking crises in the early 1990s, all bank creditors were bailed out).

[6] For example, when a savings and loan cooperative failed in 1996, the BCB covered only up to US$5000 per account. Similarly, when Banco International de Desarrollo failed in 1997, the BCB attempted to impose a limit of US$5000 per account. Runs on the banks followed this attempt, and the BCB increased the limit to US$200,000. The first US$5000 was paid in cash, and the remaining part was paid using non-interest-bearing certificates of deposits issued by the BCB with maturities ranging from two to four years.

[7] See third paragraph of Article 127, Law 2297.

[8] More than 90% of deposits and credits are in US dollars. This high degree of 'dollarization' is one of the long-lasting effects of the hyperinflation of the 1980s.

[9] See, for example, Table 1 in Demirgüç-Kunt et al. (2008).

deposits are insured—and even those are only partially covered in most cases. On average, the coverage rate of private-sector deposits is 60% and it ranges from 51% to 100%.[10] This scheme is more generous to large depositors than most systems with a coverage limit.[11]

This unusual feature of the Bolivian system was the result of pressure from financial institutions to change the first draft of the deposit insurance law that included a coverage limit of US$10,000 per account. This first draft was submitted to the Congress in 1999, but failed to pass, given the strong opposition from private interest groups.[12] The lifting of the coverage limit and the banking crisis in neighboring Argentina may have helped to bring the negotiations to an end with the passage of this modified law at the end of 2001.

The efforts to introduce explicit deposit insurance, however, started in the late 1990s following pressure from the IMF and the World Bank. This was part of a more general phenomenon. During the 1990s, these supranational organizations recommended the adoption of explicit deposit insurance in many countries as a way of containing crises and limiting implicit guarantees. As a result, the number of countries with explicit deposit insurance has increased significantly in recent years. In 1995, only 45 countries offered explicit deposit insurance. By 2003, this number increased by 78% to 87 countries.

3. Data

The database used in this paper is the Central de Información de Riesgos Crediticios (CIRC), the public credit registry of Bolivia, managed by the Bolivian Superintendent. This database contains detailed loan contract information, on a monthly basis, on all outstanding loans granted by any formal (licensed and regulated) financial institution operating in Bolivia. This includes (commercial) banks and other non-bank financial institutions such as private financial funds, credit unions, mutual societies, general deposit warehouses, and financial services companies. To keep the set of financial institutions homogeneous (in terms of financial structure and regulation), the analysis focuses on banks.[13] Our sample includes all commercial loan originations to firms between 1999:03 and 2003:12 by any bank operating in the country.[14] By analyzing only new loans (i.e., "fresh loans"), we can uncover the effect of deposit insurance on contemporaneous risk-taking. This yields 53,185 loan initiations to 4537 firms.

We only use standard debt contracts ("plain vanilla" loans), such as installment and discount loans, for which origination in a given period is a decision of the bank (this might not be the case for overdrafts, which reflect the moment the borrower draws on the authorized amount), and the likelihood of repayment is mostly firm-specific. The resulting sample includes 31,652 loans to 2666 firms. These standard debt contracts account for 92% of the total dollar value of loan initiations to firms during the sample period.

[10] The coverage rate is equal to 50 * (senior preferred obligations/total preferred obligations)$^{-1}$ if senior preferred obligations are more than 50% of the total preferred obligations and is equal to 100% otherwise. Since on average the ratio of senior to total preferred obligations is 83%, the coverage rate is on average 60%.

[11] For example, the average coverage rate for a large Bolivian depositor with US$30,000 (i.e., someone with deposits 30 times larger than the country's GDP per capita in 2003) is 60%. The corresponding coverage rate for a US depositor is 9%; in 2003, the coverage limit in the United States is US$100,000 per account and the per capita GDP is equal to US$37,658 (Demirgüç-Kunt et al., 2008).

[12] A number of recent papers have emphasized the role of private interest groups on the design of deposit insurance systems around the world (see Demirgüç-Kunt et al. (2008) and Laeven (2004) for cross-country evidence, and Kroszner and Strahan (2001) for voting behavior in the US House of Representatives).

[13] During the sample period there are twelve commercial banks, some of which are foreign owned: Banco Santa Cruz (foreign subsidiary), Banco Nacional de Bolivia, Banco Industrial, Banco Mercantil, Banco de la Unión, Banco de Crédito de Bolivia (foreign subsidiary), Banco Económico, BHN Multibanco, Banco de La Paz, Banco Ganadero, Banco Solidario, Citibank (foreign branch), Banco de la Nación Argentina (foreign branch), ABN Amro (foreign branch), Banco do Brasil (foreign branch). Although Banco Solidario is legally a bank, it serves primarily the microfinance sector, while traditionally the other banks serve only the larger firms and the elites.

[14] Prior to 1999:03 it is not possible to distinguish between commercial and consumer loans. Moreover, in 1999:01 there was a change in the way banks determine their credit ratings.

Table 1 describes the variables used in the study, and Table 2 provides summary statistics with respect to three key aspects of the dataset: loans characteristics (Panel A), bank characteristics (Panel B), and macroeconomic conditions (Panel C). As it can be observed in Panel A, 53% of the loans in the sample are discount loans and the remaining 47% are installment loans. 98% are denominated in US dollars, and the median loan size is US$44,000. The median interest rate on loans denominated in US dollars (Bolivian Pesos) is 14% (16%). Only 25% of loans are collateralized, and the median loan maturity is 6 months. At origination, the average loan has a credit rating of 1.17. The loan officer determines these ratings when a loan is issued, and they range between 1 (best) and 5 (worst), reflecting the *borrower's* repayment capacity as perceived by the bank when the loan is originated.[15] At origination, 10% of the loans in the sample have a rating of 2; 3% have ratings higher than 3. In terms of ex-post performance, 17% of the 31,652 loans in our sample had overdue payments (for at least 30 days) and 1% defaulted sometime after origination.

Approximately 71% of loans are granted to corporations, 14% to partnerships, 13% to sole proprietorships and 2% to public companies, municipalities, and civil associations. In terms of industry, 31% of the loans in the sample are in the manufacturing sector, 29% are in the retail sector, and 11% in construction. Although not reported in Table 2, the firm composition with respect to legal structure, size, and industry, is very similar to the US Survey of Small Business Finances used, for example, in Petersen and Rajan (1994).[16]

With respect to market concentration, the median loan is drawn from a relatively competitive market with a Herfindahl–Hirschman Index (HHI) equal to 1600. The HHI is calculated with the number of loans outstanding for each of the nine Bolivian provinces. In the urban regions (La Paz, Cochabamba, and Santa Cruz), where 92% of loans are originated, the HHI ranges between 1200 and 1900. The remaining six rural regions are more concentrated. Overall, the median HHI is 3500 (in a range between 1900 and 9900).

Panel B of Table 2 presents descriptive statistics for some key bank characteristics. The median bank has US$331 million of total assets. The largest bank (Banco Santa Cruz) has US$1.4 billion of total assets and represents around 25% of total bank assets at the beginning of the sample period. The median bank in the sample has an equity-to-total-assets ratio of 10.9%, a non-performing-loans-to-total-assets ratio of 8.5%, a loan-loss-reserves-to-total-assets ratio of 4%, an annualized-return-to-total-assets ratio of 0.5%, a ratio of liquid assets to total assets of 5%, an annualized interest rate of savings deposits (denominated in US$) of 3%, and a median long-term credit rating of A+. As can be seen in Table 2, all bank characteristics present considerable time-series- and cross-sectional variation.

Panel C of Table 2 provides some information about the macroeconomic conditions during the sample period. The average annual growth rate of the real GDP was 2.2%, ranging from 0.72% to 3.7%. Prices were quite stable with an average inflation rate of 2.5%, very similar to the US inflation rate, but with more variation. Because the economy is so highly 'dollarized', the exchange rate follows a crawling peg with the US dollar. During the sample period, the exchange rate depreciated at a roughly constant rate of 6.9% per annum, ranging between 5.7 and 7.8 Bolivian Pesos per US dollar. The average interest rate on 3-month Bolivian Treasury Bills (denominated in US$) was 5%, ranging between 1% and 9.4%.

Also included in this panel is the composite country risk indicator from the International Country Risk Guide (ICRG). This indicator is available on a monthly frequency, and it encompasses political,

[15] All banks use the same rating scale determined by the regulatory authority. A rating of 1 is given to borrowers with sound fundamentals (i.e., those with the capacity to repay their loan obligations in full). A rating of 2 is given to borrowers with potential but temporary problems (i.e., those that may experience or may have already experienced difficulties in paying part of their obligations, but are nevertheless expected to repay their debt in full). A rating of 3 is given to borrowers with financial weaknesses (i.e., those that at the time of evaluation have insufficient earnings to repay their debt). A rating of 4 is given to borrowers with income flows that are not enough to repay their debt in full. A rating of 5 indicates the default status. It is given when a borrower is considered insolvent. The ratings reflect the borrower's (not the loan's) repayment capacity. At a given point in time, loans to the same borrower within the same bank have the same rating, but they can have different ratings across banks. The latter is true for 19% of the 31,652 loan initiations in the sample.

[16] Ioannidou and Ongena (2008), using this database for the first time, provide detailed information about firm composition by industry, size, legal structure and number of bank–firm relationships. Note, however, that their sample is slightly different from the one in this study. For example, because they study the loan conditions at the moment when firms switch banks, they analyze loans only from firms with a prior "inside" loan.

Table 1
Definitions and notation. The table reports the notation, definition and possible values of the variables used in the analysis.

Variables	Definition/possible values
(A) Loan/firm/market characteristics	
Loan type	Installment, single-payment, credit card, overdraft
Currency of denomination	Bolivian Pesos, US dollars
Contract amount	Contract amount in thousands of US dollars
Interest rate	=Annualized loan rate
Collateral	=1 if the loan is collateralized and =0 otherwise
Maturity	Number of months between initiation and maturity
Credit rating	No problems (=1), potential problems (=2), unsatisfactory (=3), doubtful (=4), write-off (5)
Subprime	=1 if at loan origination a loan has a credit rating higher than 1, and =0 otherwise
Delinquency	=1 if any time after origination a loan has overdue payments for at least 30 days, and =0 otherwise
Default	=1 if any time after origination a loan is downgraded to a rating of 5 (default), and =0 otherwise
Legal structure	Sole proprietorships; partnerships (i.e., all or some partners have unlimited liability); corporations (i.e., all partners have limited liability); other (includes public companies, municipalities, social, cultural, sport, and religious associations)
Region	Chuquisaca, La Paz, Cochabamba, Oruro, Potosi, Tarija, Santa Cruz, Beni, Pando
Industry	Agriculture and cattle farming; forestry and fishery; extraction of oil and gas; minerals; manufacturing; electricity, gas, and water; construction; wholesale and retail trade; hotels and restaurants; transport, storage, and communications; financial intermediation; real estate activities; public administration, defense, and compulsory social security; education; communal and personal social services; activities of households as employees of domestic personnel; activities of extraterritorial organizations and bodies; other activities
Herfindahl–Hirschman Index	The sum of squared bank shares of outstanding loans calculated per month for each region
(B) Bank characteristics	
Capital ratio	Equity to total assets
Non-performing loans ratio	Non-performing loans to total assets
Loan-loss reserves ratio	Loan-loss reserves to total assets
Profitability	Profits to total assets
Liquidity ratio	Liquid assets to total assets
Log(Assets)	Log of total assets. Total assets are in millions of US$
Market share	Bank assets over total assets of the banking system
Interest rate on Deposits	Annualized interest rate on savings deposits denominated in US$
Bank rating	Long-term credit rating by Duff & Phelps, Fitch, Moody's Latin America, PCR Pacific, and Thomson financial. These ratings are available from 2000:03
(C) Macroeconomic controls	
Bolivian GDP growth	Annual growth rate of the Bolivian real gross domestic product (deflated using the GDP deflator)
US inflation rate	Annual percentage change in the US consumer price index
Bolivian inflation rate	Annual percentage change in the Bolivian consumer price index
Exchange rate change	Annual change in the Bolivian Pesos/US dollar parity
Market interest rate	Annualized interest rate on 3-month Bolivian Treasury Bills denominated in US$
Country risk indicator	ICRG country risk indicator encompassing political, financial, and economic risk in the month prior to the loan initiation
Aggregate non-performing loans ratio	Total non-performing loans in banking system to total assets in the banking system

financial and economic risks. According to the ICRG, a value of zero indicates high risk, while a value between 80 and 100 indicates very low risk. During the sample period, this indicator ranged between 65 and 70, with both minimum and maximum values in the pre-deposit insurance period. To capture the conditions of the banking sector, we also include the ratio of non-performing loans to total bank assets for the banking system as a whole. On average, this ratio is 8%, ranging from 2% to 17%.

Fig. 1 describes the time-series pattern of the growth rate of real GDP. Prior to the introduction of deposit insurance, the growth rate shows big fluctuations, with growth rates near zero around the end of 1999. Starting 4 months before the introduction of deposit insurance, the growth rate of real GDP follows a stable and increasing trend, with a peak of 3.9% in July 2003. This time-series pattern indicates that the introduction of deposit insurance did not coincide with a period of increased macroeconomic uncertainty.

Table 2
Descriptive statistics. The table reports the mean, the standard deviation, the median, the minimum, and the maximum values for selected loan, firm, market, and bank characteristics, as well as indicators of macroeconomic conditions. For loan, firm, and market characteristics, the unit of observation is the number of loans; for the bank characteristics it is the number of bank-month observations, and for the macroeconomic conditions it is the number of months.

	Obs	Mean	St. dev.	Median	Min	Max
(A) Loan/firm/market characteristics						
Installment	31,652	0.47	0.50	0.00	0.00	1.00
Single-payment	31,652	0.53	0.50	1.00	0.00	1.00
Denominated in US$	31,652	0.98	0.13	1.00	0.00	1.00
Contract amount (in thousands of US$)	31,652	164.16	473.62	44.00	0.00	12212.81
Interest rate	31,652	13.63	2.90	14.00	0.01	35.00
Loans denominated in US$	31,652	13.60	2.84	14.00	0.01	35.00
Loans denominated in Bolivian Pesos	31,652	15.38	4.99	16.00	1.00	33.00
Collateral	31,652	0.25	0.43	0.00	0.00	1.00
Maturity (in months)	31,652	10.97	16.54	5.90	0.00	180.43
Credit rating	31,652	1.17	0.51	1.00	1.00	5.00
Credit Rating_1	31,652	0.87	0.34	1.00	0.00	1.00
Credit Rating_2	31,652	0.10	0.30	0.00	0.00	1.00
Credit Rating_3	31,652	0.02	0.15	0.00	0.00	1.00
Credit Rating_4	31,652	0.004	0.064	0.00	0.00	1.00
Credit Rating_5	31,652	0.003	0.059	0.00	0.00	1.00
Delinquency	31,652	0.17	0.38	0.00	0.00	1.00
Default	31,652	0.01	0.11	0.00	0.00	1.00
Corporations	31,652	0.71	0.45	1.00	0.00	1.00
Partnerships	31,652	0.14	0.35	0.00	0.00	1.00
Sole proprietorships	31,652	0.13	0.33	0.00	0.00	1.00
Manufacturing	31,652	0.31	0.46	0.00	0.00	1.00
Retail	31,652	0.29	0.46	0.00	0.00	1.00
Construction	31,652	0.11	0.31	0.00	0.00	1.00
Herfindahl–Hirschman Index	31,652	0.18	0.08	0.16	0.12	0.99
(B) Bank characteristics						
Equity to total assets	715	14.35	9.03	10.90	5.14	58.13
Non-performing loans to total assets	715	9.69	6.93	8.53	0.60	41.60
Loan-loss reserves to total assets	715	5.37	3.99	4.19	0.49	21.61
Return on total assets	715	−0.43	6.99	0.51	−114.32	48.50
Liquid assets to total assets	715	6.66	5.38	5.20	0.94	43.74
Total assets (in millions of US$)	715	380.31	287.66	331.35	15.11	1437.32
Market share (in terms of total assets)	715	8.11	5.88	6.38	0.31	25.82
Interest rate on deposits	678	3.02	2.04	3.04	0.01	7.00
Bank rating	546	A		A+	C	AAA
(C) Macroeconomic controls						
Bolivian GDP growth	58	2.17	0.71	2.26	0.72	3.74
US inflation rate	58	2.45	0.75	2.33	1.07	3.70
Bolivian inflation rate	58	2.47	1.56	2.50	−1.23	6.42
Exchange rate	58	6.69	0.66	6.61	5.68	7.77
Exchange rate change	58	0.43	0.11	0.40	0.27	0.67
Market interest rate	58	5.01	2.27	4.98	1.16	9.41
Country risk indicator	58	67.29	1.13	67.50	64.80	69.80
Aggregate nonperforming loans ratio	58	7.87	4.16	7.17	2.03	16.55

4. Methodology

4.1. Baseline model

This section begins by investigating whether the probability of initiating risky (or subprime) loans is affected by the introduction of deposit insurance. The key independent variable is the deposit insurance dummy, *DI*, which equals 1 after December 2001 (when the deposit insurance was introduced), and 0 otherwise. The bank's internal rating for each loan at the time of origination is used to identify

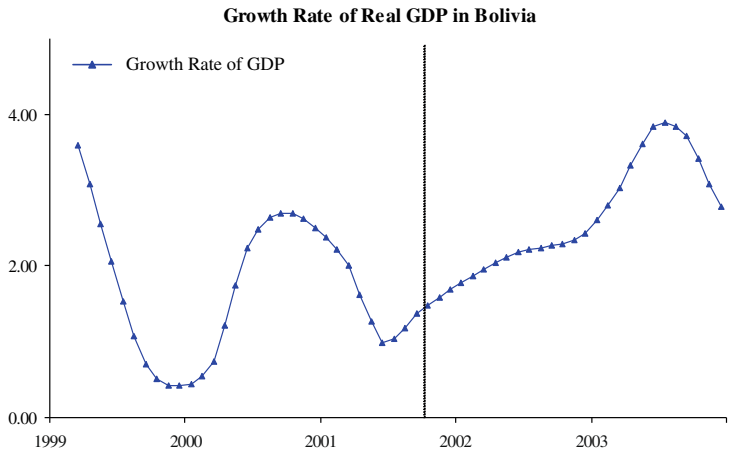

Fig. 1. Growth rate of real GDP. This figure describes the time-series pattern of the growth rate of real GDP in Bolivia between March 1999 and December 2003. The vertical line indicates when deposit insurance was introduced.

whether a loan is risky. Our key dependent variable, *Subprime*, takes the value of 1 if at origination a loan has a credit rating higher than 1, and is equal to 0 otherwise (i.e., loans with ratings higher than 1 are considered riskier or subprime). Before turning to the description of the control variables, we investigate how the various ratings relate to loan interest rates at origination and ex-post loan performance.

In Panel A of Table 3, we regress the loan interest rate on the credit ratings, controlling for currency denomination and time fixed effects using month/year dummy variables. Loans with ratings equal to 2 have interest rates that are 50 basis points higher than the rates on loans with ratings equal to 1. Similarly, loans with ratings equal to 3, 4 and 5 have interest rates that are, respectively, 162, 185 and 481 basis points above the rates of loans with rating equal to 1. In the sample, there are 109 loans issued with a rating of 5 (i.e., they are at the default status at origination). The vast majority of these loans, 83%, have maturities of only one day. Since we fear that such loans might be the result of accounting procedures and reporting issues—not necessarily related to current risk-taking—we drop them from the sample. All results presented from now on in the paper, do not include these loans.[17]

In Panel B of Table 3, we investigate the relationship between the various credit ratings and ex-post performance. A loan's ex-post performance is evaluated using two criteria: whether sometime after origination overdue payments occur for more than 30 days (delinquent) and whether the loan is downgraded to a rating of 5 (default). As mentioned earlier, 17% of the loans in our sample had overdue payments and 1% were downgraded to 5 sometime after origination. As can be observed in Table 3, loans with worse ratings at origination are more likely to have repayment problems later on. For example, loans with ratings equal to 2 are more than twice as likely to go past due or default as loans with ratings equal to 1. Loans with ratings equal to 3 or 4 at origination are at least four times more likely to have overdue payments than loans with ratings equal to 1 and eight times more likely to default.

Finally, we also examine whether the probability of ex-post non-performance associated with each rating changed after the introduction of deposit insurance. We want to ensure that any effects of *DI* on the probability of initiating riskier loans are *not* due to changes in the way in which banks assign their ratings. For example, if each rating is associated with a lower probability of ex-post non-performance when $DI = 1$, finding that *DI* is associated with a higher probability of initiating loans with worse ratings would not necessarily imply that banks take more risk. To investigate this, we estimate a Probit model on the probability of ex-post non-performance. Like in Panel B, we employ two alternative

[17] Including these loans in the sample, however, does not qualitatively alter any of the results.

Table 3
Loan interest rates, ratings, and ex-post performance. *Panel A* reports the estimated coefficients of an Ordinary Least Squares (OLS) regression of loan rates on credit ratings at origination, controlling for currency denomination and time fixed effects using month/year dummy variables. Two specifications are reported: one with all loans (Column I) and one where loans with rating equal to 5 are excluded (Column II). *Panel B* reports the percentage of loans in each rating category that had ex-post repayment problems: delinquency (had overdue payments for at least 30 days anytime after origination) or default (downgraded to a rating of 5 anytime after origination). The percentages in Panel B are calculated excluding loans with a rating of 5 at origination. The same holds for Panels C and D. *Panel C* reports the estimated coefficients of two Probit models on the probability of delinquency or default. All bank and macro controls are used with a lag of 1 month. In all cases, the standard errors of the reported coefficients are clustered at the firm level and are reported between brackets. ***, **, and * indicate significance at the 1%, 5% and 10% levels, respectively. *Panel D* reports the number and percentage of loans in each rating category (at origination) for the two periods: before and after deposit insurance. The stars in Panel D indicate the significance of an *F*-statistic testing the equality of the two means.

	I		II	
(A) Pricing				
Constant	16.238***	[1.114]	16.245***	[1.114]
Credit Rating_2	0.503***	[0.120]	0.501***	[0.120]
Credit Rating_3	1.62***	[0.251]	1.617***	[0.251]
Credit Rating_4	1.852***	[0.422]	1.851***	[0.423]
Credit Rating_5	4.808***	[0.495]		
Number of observations	31,652		31,543	
R-Square	0.29		0.29	
	Delinquency		Default	
(B) Credit ratings and ex-post performance				
Credit Rating_1	13.98		0.89	
Credit Rating_2	32.22		2.12	
Credit Rating_3	63.05		7.18	
Credit Rating_4	66.92		13.85	
	Delinquency		Default	
(C) Credit ratings and ex-post performance: before and after DI				
Constant	2.588**	[1.223]	−2.22	[1.544]
DI	−0.176	[0.134]	−0.086	[0.175]
Credit Rating_2	0.531***	[0.077]	0.209**	[0.085]
Credit Rating_3	1.333***	[0.152]	0.837***	[0.145]
Credit Rating_4	1.206***	[0.207]	0.988***	[0.221]
(Credit Rating_2)**DI*	0.217	[0.154]	0.362	[0.225]
(Credit Rating_3)**DI*	0.338	[0.238]	0.305	[0.257]
(Credit Rating_4)**DI*	0.447	[0.305]	0.682	[0.505]
Growth rate of real GDP, inflation rate, exchange rate change, country risk	Included		Included	
Number of observations	31,543		31,543	
Pseudo *R*-square	0.08		0.07	
	Number		Percentage	
	Before *DI*	After *DI*	Before *DI*	After *DI*
(D) Loans under each credit rating: before and after DI				
Credit Rating_1	18,482	9049	85.91***	90.22
Credit Rating_2	2421	695	11.25***	6.93
Credit Rating_3	514	252	2.39	2.51
Credit Rating_4	96	34	0.45*	0.34
Total	21,513	10,030	100.00	100.00

measures of non-performance: *delinquency* and *default*. For both models, the key explanatory variables are four dummy variables, one for each rating, and their interactions with *DI*. The results, presented in Panel C of Table 3, show that no systematic changes occur to the relationship between the probability of delinquency or default and the credit ratings.

All in all, these results suggest that using the credit ratings to investigate ex-ante risk-taking is a reasonable empirical strategy. Banks charge higher interest rates on loans they mark as risky, those loans are associated with worse ex-post performance, and there are no systematic changes in the

way in which banks assign their ratings before and after the introduction of deposit insurance—at least as far as ex-post performance measures suggest.

We turn now to the control variables, and explain the rationale behind them. As shown in Fig. 1 the macroeconomic conditions improved in the post-deposit insurance period. This is also reflected in the (unconditional) incidence of *Subprime* loans, which falls after the introduction of deposit insurance from 14.1% to 9.8% (Panel D of Table 3). Hence, in order to investigate the effect of deposit insurance on risk-taking we need to control for changes in macroeconomic conditions that might affect the quality of the pool of applicants.

Local market competition may also change the average quality of the pool of applicants. According to Broecker (1990), more competition increases adverse selection problems, which in turn may make banks more conservative in rating their customers (i.e., they know that in more competitive markets they are more likely to face a "bad type" borrower, and thus they rate more conservatively). It is also possible that in more competitive markets, banks are willing to relax their lending standards in exchange for market share.

To ensure that *DI* is capturing a structural break and not a trend, we also include a time trend among the control variables. Without the time trend, *DI* could be capturing changes in risk-taking that happen slowly over time, such as advances in information technology (e.g., credit scoring) that may increase the willingness of banks to service the *Subprime* market or the loosening of credit standards that could accompany the improving macroeconomic conditions in Bolivia during our sample period (see Fig. 1).

To explore whether the effect (if any) of deposit insurance is driven by a few risky banks issuing a larger proportion of loans in the post-deposit insurance period, the benchmark model is augmented by introducing bank fixed effects, exploiting only within-bank variation. Bank fixed effects could also be capturing possible differences among banks on the criteria they use to determine their ratings—although this is not expected to have a first-order effect, since (as mentioned earlier) such differences are relatively rare.

4.2. Cross-sectional identification strategy

The richness of the database allows us to analyze not only the risk-taking behavior of banks before and after deposit insurance, but also the way in which various *bank* characteristics might affect this behavior. This cross-sectional analysis (apart from being interesting in itself) is a key component of the identification strategy in this paper.

4.2.1. Share of large deposits

Economic theory and existing empirical evidence suggests that market discipline in the deposit market originates mainly from large depositors.[18] In general, large depositors have more at stake, are more sophisticated, and expect to gain less from ex-post bailout policies—as governments often impose coverage limits per account.

Using data from Bolivia, de Dreu and Ioannidou (2006) found that large depositors, prior to the introduction of deposit insurance, disciplined riskier banks by withdrawing their deposits. Their responsiveness decreased significantly after the introduction of deposit insurance, which granted all depositors (regardless of their size) a generous explicit guarantee. Taking these results at face value, one would expect that prior to the introduction of deposit insurance, banks with a high percentage of large deposits would take less risk. This effect should be significantly reduced or even disappear in the post-deposit insurance period.

To test this hypothesis, we introduce the share of large deposits on total deposits. Table 4 describes the composition of deposits by size. For the average bank, 92% of the dollar value of total deposits comes from accounts with at least US$5000; 76% comes from accounts with at least US$30,000; only 44% comes from accounts with at least US$200,000. The composition of deposits by size is relatively

[18] See, among others, Dewatripont and Tirole (1994), Diamond and Dybvig (1983), Ellis and Flannery (1992), Flannery and Sorescu (1996), Park and Peristiani (1998), and Martinez Peria and Schmukler (2001).

Table 4
Share of large deposits. This table reports descriptive statistics for the share of large deposits, using different thresholds for the size of the large accounts.

	Obs	Mean	St. dev.	Median	Min	Max
(A) Composition of deposits by size						
>US$5000	715	0.92	0.05	0.92	0.82	1.00
>US$30,000	715	0.76	0.11	0.74	0.55	0.99
>US$50,000	715	0.69	0.13	0.64	0.45	0.98
>US$200,000	715	0.44	0.17	0.38	0.16	0.87
>US$500,000	715	0.24	0.13	0.19	0.00	0.67
>US$1,000,000	715	0.14	0.11	0.11	0.00	0.58
	Before			After		
	Mean	St. dev.	Median	Mean	St. dev.	Median
(B) Composition of deposits by size: before and after deposit insurance						
>US$5000	0.93	0.05	0.93	0.92	0.05	0.90
>US$30,000	0.77	0.10	0.76	0.75	0.13	0.71
>US$50,000	0.70	0.12	0.68	0.67	0.15	0.62
>US$200,000	0.45	0.15	0.42	0.42	0.20	0.35
>US$500,000	0.26	0.14	0.21	0.20	0.11	0.18
>US$1,000,000	0.16	0.12	0.12	0.12	0.10	0.09

stable over time. There is, however, considerable cross-sectional variation for thresholds higher than US$5000. At sample entry, there are banks with 60% of their deposits from accounts with at least US$30,000, and other banks with a corresponding value of 91%. For the analysis we use the US$30,000 threshold for large deposits, but in the robustness section we experiment with alternative thresholds.

4.2.2. Drop in the cost of deposits

If it is the reduction in depositor discipline that spurs the increase in risk-taking in the second period, then we should observe that the banks that experienced the largest drop in their cost of deposits (i.e., the riskiest banks that benefited the most from the introduction of deposit insurance) are those that take more risk in the second period. de Dreu and Ioannidou (2006) found that both the level and the sensitivity of deposit rates to bank risk decreased significantly in the post-deposit insurance period. For example, before the introduction of deposit insurance, an AAA bank paid no more than 2.5% for its (US$ denominated) savings deposits, while a BBB− or a BBB bank paid at least 4.5%. The correlation between the rates on savings deposits and bank ratings was 0.76.[19] Afterwards, no bank paid more than 2.5% for their savings deposits, and the correlation dropped to −0.09.

To capture these cross-sectional differences, we calculate the *drop in the cost of deposits* as the difference between a bank's average rate on savings deposits in the 6 months prior to introduction of deposit insurance and the average rate in the subsequent 6 months.[20] Using the change of deposit rates around that time allows us to abstract from other factors that may also affect the level of interest rates (such as market competition and bank efficiency). We then examine whether this variable is positively correlated with the probability of originating a *Subprime* loan in the second period. This model is estimated for a sub-sample starting 7 months after the introduction of deposit insurance till the end of the sample, so that the key explanatory variable is predetermined.

4.2.3. Too-big-to-fail

Larger bank size leads to increases in the potential systemic risk that an institution can trigger if it experiences credit or liquidity problems. Hence, most governments adhere to too-big-to-fail

[19] Correlations were calculated by using a categorical variable mapping the ratings into numerical values as follows: AAA = 1, AAA− = 2, AA+ = 3, AA = 4,. . ., C = 25.

[20] The drop in the cost of deposits equals on average 2.03%, and has a standard deviation of 1.28%, a minimum value of 0% (from a AA bank), and a maximum of 3.98% (from a bank with a BBB−). The correlation between this variable and bank ratings is 0.51 (the correlation is again calculated using the categorical variable).

policies, protecting the uninsured debt-holders of large insolvent banks whose failure could trigger contagion in the financial system. To attenuate the resulting moral hazard problem, however, most governments either claim that such policies do not exist or use the "constructive ambiguity" approach. Although in such a context investors are uncertain ex-ante about whether and which banks will be bailed out, ceteris paribus, the larger the bank the more likely it is to be deemed as "too-big-to-fail".

These implicit guarantees may limit the risk-sensitivity of banks' cost of funds, and therefore lead them to optimally take more risk.[21] If too-big-to-fail guarantees were present in Bolivia, one would expect very large banks to take more risk than smaller banks. However, because deposit insurance introduced explicit guarantees on all banks regardless of their size, this effect should be significantly reduced or even completely eliminated after December 2001. Since it is always difficult to determine ex-ante the too-big-to-fail threshold, we introduce in our specifications both a linear and a non-linear term for bank size, *Log*(*Assets*) and *Log*(*Assets*)_*Square*, to estimate this threshold.

5. Results

5.1. Baseline model

Table 5 reports the results of a baseline Probit model in Column I. This model estimates how the introduction of deposit insurance affects the probability of issuing a *Subprime* loan, controlling for changes in macroeconomic conditions and competition in the local loan markets. These control variables are included with a lag of 1 month (the same holds for all future specifications). The time trend is also included in the specification. Column II augments this baseline model by introducing bank fixed effects. For each specification the table shows the estimated coefficients from the Probit model, their standard errors, and their significance levels. In all cases, the standard errors are clustered at the firm level (the same holds for all future specifications).

The estimated coefficients of *DI* are always positive and statistically significant, suggesting that after the introduction of deposit insurance, banks are more likely to initiate riskier loans.[22] The marginal effects of the estimated coefficients in Columns I and II suggest that the probability of issuing *Subprime* loans increases by 6.8% and 6.0%, respectively. Given that the predicted probabilities of *Subprime* loans are only 12.3% in Column I, and 11.8% in Column II (i.e., there are relatively few of them), the likelihood of these loans in the second half of the sample increases by more than 56%. The estimated coefficient of *DI* does not change a lot when bank fixed effects are included in the specifications, suggesting that this coefficient is driven mainly by variation over time within each bank. Note, however, that in terms of goodness of fit and prediction accuracy, the model improves significantly. When bank fixed effects are added, the correct predictions increase to 63% (from 58%) and the Type I and Type II errors are reduced to 39% (from 47%) and 33% (from 37%), respectively.[23]

With respect to the control variables, the growth rate of real GDP has a negative and statistically significant coefficient, suggesting that the quality of the pool of applicants improves when macroeconomic conditions improve. Similarly, the estimated coefficient of the time trend is negative and statistically significant, capturing perhaps improvements in the pool of applicants that are not fully accounted for by the growth rate of real GDP (see Fig. 1). The coefficient of

[21] Penas and Ünal (2004), for example, find evidence of a too-big-to-fail effect on the cost of bank debt. They compare bond yields at issue before and after a bank merger, and find a significant larger decrease in spreads for the group of banks that were able to push the asset size above the too-big-to-fail threshold after the merger.

[22] To investigate whether our results are driven by the over-indebtedness of the microfinance sector in the late 1990s and the introduction of the first microfinance private credit bureau, FINRURAL, in 2000 (see Campion (2001) and Luoto et al. (2007)), we re-estimate our baseline model excluding Banco Solidario, which specializes in microcredit. We also re-estimate our model excluding all proprietorships (i.e., the category of firms which is most likely to include firms that are traditionally customers of microcredit institutions). In both cases, the results are unchanged, suggesting that the dynamics in the microfinance sector are not correlated with our *DI* dummy.

[23] As shown in the robustness section, adding additional controls (such as firm and loan characteristics) further improves the model's prediction accuracy, but leaves our main findings unchanged.

Table 5
Baseline model. This table reports the estimated coefficients of Probit regressions in Columns I and II, and the estimated coefficients of an Ordered Probit in Column III. The dependent variable in Columns I and II is *Subprime*, a dummy variable that equals one if at origination a loan has a credit rating higher than 1, and is equal to zero otherwise. The dependent variable in Column III is the credit rating at origination, which takes the values of 1 (no problems), 2 (potential problems), 3 (unsatisfactory) or 4 (doubtful). Loans with ratings equal to 5 at origination are not included in the sample. All bank and macro controls are used with a lag of 1 month. In all cases, the standard errors of the reported coefficients are clustered at the firm level and are reported between brackets. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

	Subprime		*Credit rating*
	I	II	III
Constant	−1.126	−0.609	
	[0.954]	[1.000]	
Deposit insurance dummy	0.314***	0.285***	0.281***
	[0.089]	[0.091]	[0.085]
Bolivian GDP growth	−0.063**	−0.062**	−0.069**
	[0.031]	[0.031]	[0.029]
Bolivian inflation rate	0.011	0.017	0.015
	[0.017]	[0.017]	[0.016]
Exchange rate change	−0.544	−0.520	−0.644
	[0.600]	[0.626]	[0.569]
Market interest rate	−0.024*	−0.024*	−0.023
	[0.014]	[0.014]	[0.015]
Country risk indicator	0.015	0.016	0.018
	[0.014]	[0.014]	[0.013]
Aggregate non-performing loans ratio	−0.013	−0.057**	−0.053**
	[0.015]	[0.027]	[0.025]
Trend	−0.017***	−0.017***	−0.015***
	[0.005]	[0.005]	[0.004]
Herfindahl–Hirschman Index	−1.035	−1.232	−1.311*
	[0.737]	[0.842]	[0.777]
Bank fixed effects	No	Yes	Yes
Cut-off point 1			0.849
			[0.948]
Cut-off point 2			1.644
			[0.947]
Cut-off point 3			2.403
			[0.944]
Number of observations	31,543	31,543	31,543
Pseudo *R*-square	0.02	0.04	0.03
Correct predictions	58%	63%	
Type I error	47%	39%	
Type II error	37%	33%	

the aggregate non-performing loans ratio is negative and statistically significant in Column II, consistent with banks being more cautious or facing more regulatory pressure when portfolios deteriorate. The same holds for the coefficient of market interest rates. Finally, the coefficients of the Bolivian inflation rate and the ICRG composite country risk indicator are not statistically significant.

In Column III of Table 5 we report the results of an Ordered Probit, which allows us to consider each individual credit rating as a different outcome. The explanatory variables are the same as the ones used in the Probit model of Column II (with bank fixed effects). Consistent with the previous results, the coefficient of *DI* is positive and statistically significant at the 1% level, indicating that loans with rating equal to 4 (the worst category) are more likely in the second period. Using the estimated cut-off points (reported in Column III) we also calculate the marginal effect of *DI* on each rating. We find that in the post-deposit insurance period, loans with ratings equal to 2 are 4.1% more likely. The corresponding numbers for loans with ratings equal to 3 and 4 are 1.5% and 0.3%, respectively. Given their predicted probabilities, these changes amount to a 44%, 70% and 100% increase in the

incidence of loans with ratings equal to 2, 3, and 4, respectively.[24] In terms of the *cumulative* effect of *DI* on all three subprime ratings, the results are very similar to those found using the Probit model (i.e., after the introduction of deposit insurance, loans with ratings equal to 2, 3, and 4 are 5.9% more likely; very similar to the 6.0% increase found using the Probit model).

With respect to the control variables, the Ordered Probit results are consistent with those found earlier. The growth rate of real GDP, the aggregate non-performing loans ratio, and the time trend are negative and statistically significant. In addition, the coefficient of HHI is negative and statistically significant, suggesting that competition in the local loan markets is associated with a higher probability of *Subprime* loans, consistent with our expectations.

Overall, our findings suggest that banks are more likely to initiate riskier loans after the introduction of deposit insurance. Although this is consistent with more risk-taking in response to the introduction of deposit insurance, it is possible that our controls do not adequately capture all possible time-series changes that might be correlated with *DI*. Hence, we now turn to the cross-sectional analysis, and examine whether the effect of selected bank characteristics is consistent with the interpretation of our results.

5.2. Cross-sectional identification strategy

The share of large deposits on total deposits, *Share of Large Deposits*, the drop in the cost of deposits following the introduction of deposit insurance, *Drop in the Cost of Deposits*, and bank size, *Log*(*Assets*) and *Log*(*Assets*)_*Square*, are our key explanatory variables. If deposit insurance is behind the findings, then these variables should have very specific (and different) effects before and after the introduction of deposit insurance.

Instead of introducing interaction terms between the key explanatory variables and *DI*, we take a more conservative approach, allowing all coefficients to vary by splitting the sample in two periods: before and after deposit insurance. Since most of the variation in the key variables is cross-sectional, the bank fixed effects are replaced with time-varying bank characteristics. Before doing this, however, we re-estimate the baseline model using the new set of controls.[25] The results, presented in Column I of Table 6, are very similar to those presented earlier. Our key variable, *DI*, has a positive and statistically significant coefficient.

Columns II and III of Table 6 report the findings for the two sub-periods. For the first period, the *Share of Large Deposits* has a negative and statistically significant coefficient, consistent with large depositors disciplining their banks prior to the introduction of deposit insurance. In terms of economic significance, an increase in the *Share of Large Deposits* by one standard deviation (11%) reduces the probability that a bank will initiate a *Subprime* loan by 5.3%, which implies a decrease in the likelihood of *Subprime* loans by 40%.[26] This effect disappears after the introduction of a system that provides large depositors with a generous explicit guarantee (i.e., the *Share of Large Deposits* has a positive and statistically insignificant coefficient with a *p*-value equal to 0.62). We view this result as one of our main findings as it not only strengthens our identification strategy, but it provides direct empirical evidence of the specific channel through which deposit insurance increases bank risk-taking.

The results are also consistent with a too-big-to-fail effect prior to the introduction of deposit insurance. Large banks are less likely to initiate riskier loans, but very large banks (those that tend to be subject to too-big-to-fail guarantees) take more risk. The estimates suggest that the too-big-to-fail effect kicks in for market shares larger than 18.2%. After the introduction of deposit insurance,

[24] We also estimate a generalized Ordered Probit that relaxes the assumption of proportional odds, allowing the coefficients of all explanatory variables to be different across the various outcomes. The estimation results are similar to those of Column III. Thus, we do not report them in the paper, but we make them available upon request.

[25] In these specifications we do not include the banking system's ratio of non-performing loans since it is highly correlated with its bank-level counterpart. The correlation between the two variables in our sample is 0.77.

[26] The predicted probability of *Subprime* loans (at the mean of all other independent variables) is 13.2%. Similar results are obtained using an Ordered Probit model. We find that an increase in the *Share of Large Deposits* by one standard deviation (11%) decreases the probability of loans with ratings equal to 2, 3, and 4 by 3.9%, 1.1%, and 0.2%, respectively. Given the predicted probabilities, these decreases amount to a 35.5%, 54.8%, and 72.8% decrease in the incidence of loans with rating 2, 3 and 4, respectively.

Table 6
Cross-sectional identification. This table reports the estimated coefficients of Probit regressions, where the dependent variable is *Subprime*, a dummy variable that equals one if at origination a loan has a credit rating higher than 1, and is equal to zero otherwise. Loans with ratings equal to 5 at origination are not included in the sample. The *Drop in the Cost of Deposits* is equal to the difference between a bank's average rate on savings deposits in the 6 months prior to the introduction of deposit insurance and the average rate in the subsequent 6 months. The model is estimated for a sub-sample starting from 7 months after the introduction of deposit insurance till the end of the sample. All bank and macro controls are used with a lag of 1 month. In all cases, the standard errors of the reported coefficients are clustered at the firm level and are reported between brackets. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

	Subprime			
	I All	II *DI* = 0	III *DI* = 1	IV *DI* = 1
Constant	1.568	7.127***	−11.668**	11.744**
	[1.876]	[1.941]	[5.662]	[5.370]
Deposit insurance dummy	0.224**			
	[0.097]			
Share of large deposits	−1.522***	−2.258***	0.313	
	[0.470]	[0.535]	[0.638]	
Log(Assets)	−0.444	−1.158**	0.762	
	[0.517]	[0.450]	[1.668]	
Log(Assets)_Square	0.032	0.076**	−0.049	
	[0.044]	[0.037]	[0.154]	
Drop in the cost of deposits				0.124**
				[0.058]
Capital ratio	−0.007	−0.041***	−0.002	
	[0.014]	[0.014]	[0.028]	
Non-performing loans ratio	−0.002	−0.035***	0.047***	
	[0.009]	[0.012]	[0.014]	
Loan-loss reserves ratio	0.015	0.048**	−0.041*	
	[0.020]	[0.022]	[0.023]	
Profitability	0.016**	0.009*	0.015	
	[0.007]	[0.005]	[0.014]	
Liquidity ratio	−0.009	−0.028***	0.033	
	[0.009]	[0.009]	[0.022]	
Bolivian GDP growth	−0.059	−0.153***	0.039	0.014
	[0.036]	[0.040]	[0.123]	[0.139]
Bolivian inflation rate	0.015	0.064***	−0.114***	0.198**
	[0.020]	[0.022]	[0.044]	[0.100]
Exchange rate change	−0.408	−2.525*	−0.916	−4.392***
	[0.612]	[1.508]	[0.667]	[1.049]
Market interest rate	−0.023*	−0.045***	−0.028*	−0.020
	[0.013]	[0.017]	[0.017]	[0.024]
Country risk indicator	0.013	0.002	0.115**	−0.061
	[0.013]	[0.016]	[0.051]	[0.056]
Aggregate non-performing loans ratio				−0.056
				[0.045]
Trend	−0.018***	−0.014*	0.000	−0.140***
	[0.005]	[0.007]	[0.011]	[0.039]
Herfindahl–Hirschman Index	−1.038	−1.413	−0.649	−1.508*
	[0.779]	[0.975]	[0.655]	[0.839]
Number of observations	31,302	20,087	11,215	6011
R-Squared	0.03	0.04	0.02	0.05
Correct predictions	58%	58%	58%	64%
Type I error	39%	33%	41%	44%
Type II error	38%	39%	39%	33%

which granted explicit guarantees to *all* banks, this effect disappears (both *Log*(*Assets*) and *Log* (*Assets*)_*Square* have insignificant coefficients).

It should be pointed out that there is only one bank (out of 12) with a market share above 18%. This is not surprising, as one would expect that only a small percentage of a country's banking sector would

qualify for too-big-to-fail guarantees. Nevertheless, these results should be assessed with caution. Even if the estimates draw from the several thousands of loans that this bank issued during the sample period, the data still describe the behavior of one bank. It is therefore possible that the results capture something idiosyncratic about this bank and not a too-big-to-fail effect that disappeared in the post-deposit insurance period.[27]

There are also some interesting results regarding some other bank characteristics, which are mainly used as control variables. Prior to the introduction of deposit insurance, banks with higher capital ratios (i.e., those whose stockholders have more to lose in the event of a bank run) take less risk. Contrary to expectations, this effect is not only attenuated, but is completely eliminated in the post-deposit-insurance period.[28] Controlling for bank capital, banks with worse portfolios (those with more non-performing loans and lower loan-loss reserves with respect to their size) take less risk in the first part of the sample. The effect is reversed in the second half: with deposit insurance, banks with worse portfolios are more likely to issue subprime loans, consistent with theoretical predictions (Merton, 1977).

In the pre-deposit insurance period, many of the estimated coefficients of the macroeconomic indicators are statistically significant and have expected signs. In the second period, however, many of them are not statistically significant. This is because in the second period the correlation between some of these variables is much higher, making difficult to separate out their effects. Specifically, the time trend, the growth rate of real GDP, and the inflation rate are highly correlated. This probably explains why the estimated coefficients of the time trend and the GDP are not statistically significant in Column III.[29] It should be emphasized, however, that in both periods our key explanatory variable, the *Share of Large Deposits*, is not highly correlated with any of the control variables.

Next, in Column IV we examine whether the banks that experienced the largest drop in their cost of deposits (i.e., the riskiest banks that benefited the most from the introduction of deposit insurance) are those that take more risk in the second period. Using the *Drop in the Cost of Deposits* (defined as the difference between a bank's average rate on savings deposits in the 6 months prior to introduction of deposit insurance and the average rate in the subsequent 6 months), we estimate a specification similar to the baseline for a sub-sample starting 7 months after the introduction of deposit insurance until the end of the sample. As expected, the drop in the cost of deposits has a positive and statistically significant coefficient. This effect is also economically relevant, since a one-percent decrease in the cost of deposits is associated with a 24% increase in the incidence of *Subprime* loans.[30]

5.3. Contract terms

Our findings indicate a significant increase in risk-taking after the introduction of deposit insurance, based on evidence that relies on the credit ratings assigned by banks when loans are originated. As mentioned earlier, these ratings are borrower-based rather than loan-based, reflecting the borrower's capacity of repayment. This implies that banks do not take into account contract terms, such as collateral and maturity, when they determine these ratings.

Hence, it is possible that while banks originate riskier loans after the introduction of deposit insurance, they also compensate for that extra risk by requiring collateral or shortening maturities. Requiring collateral not only reduces losses when default occurs, but it also mitigates agency

[27] A coincidence is always more likely for one bank rather than a group of banks.

[28] Models of deposit insurance suggest that banks with lower capital ratios have more incentives to take advantage of the deposit insurance subsidy by taking on more risk (see, for example, Merton (1977)).

[29] Dropping the inflation rate from these specifications makes the coefficient of the time trend negative and statistically significant. If the time trend is also dropped, the coefficient of the GDP becomes negative and statistically significant. In both cases, the results with respect to our key explanatory variables are unchanged.

[30] Similar results are obtained using an Ordered Probit model. We find that a one-percent decrease in the cost of deposits increases the incidence of loans with ratings 2, 3 and 4 by 21.4%, 29.6%, and 42%, respectively.

Table 7
Contract terms. This table reports the estimates coefficients of Probit regressions for *Collateral*, a dummy variable that equals one if the loan has collateral pledged, and is equal to zero otherwise, and the estimated coefficients of OLS regressions for *Maturity*, a continuous variable indicating the number of months between initiation and maturity. Loans with ratings equal to 5 at origination are not included in the sample. All bank and macro controls are used with a lag of 1 month. In all cases, the standard errors of the reported coefficients are clustered at the firm level and are reported between brackets. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

	Collateral			*Maturity*		
	I All	II *DI* = 0	III *DI* = 1	IV All	V *DI* = 0	VI *DI* = 1
Constant	0.474	0.927	1.303	42.748***	35.062**	51.196***
	[0.834]	[0.898]	[2.456]	[14.246]	[17.698]	[17.921]
Deposit insurance dummy	−0.420***			0.237		
	[0.073]			[1.259]		
Subprime		0.094*	0.278*		3.224*	0.019
		[0.057]	[0.147]		[1.759]	[0.870]
Bolivian GDP growth	−0.049*	0.023	−0.145	−0.226	−0.166	−0.878
	[0.026]	[0.028]	[0.114]	[0.438]	[0.389]	[1.172]
Bolivian inflation rate	−0.052***	−0.066***	−0.032	0.099	−0.076	0.094
	[0.013]	[0.014]	[0.033]	[0.249]	[0.261]	[0.280]
Exchange rate change	0.052	2.489***	0.18	−7.178*	5.792	−1.947
	[0.260]	[0.883]	[0.441]	[4.313]	[18.742]	[3.729]
Market interest rate	−0.071***	−0.054***	−0.065**	0.003	0.188	−0.262***
	[0.014]	[0.016]	[0.030]	[0.151]	[0.319]	[0.088]
Country risk indicator	−0.031***	−0.048***	−0.058*	−0.205	−0.155	−0.444*
	[0.012]	[0.014]	[0.035]	[0.224]	[0.326]	[0.247]
Aggregate non-performing loans ratio	0.120***	0.100***	0.138***	−1.086***	−1.208***	−0.711***
	[0.017]	[0.017]	[0.028]	[0.091]	[0.104]	[0.121]
Trend	0.013***	0.008*	0.019*	−0.099***	−0.14**	−0.006
	[0.003]	[0.005]	[0.010]	[0.025]	[0.063]	[0.101]
Herfindahl–Hirschman Index	−0.041	0.236	−0.031	3.132	6.589***	−1.021
	[0.283]	[0.485]	[0.430]	[1.918]	[2.393]	[2.297]
Bank fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	31,543	21,513	10,030	31,543	21,513	10,030
(Pseudo) *R*-square	0.18	0.19	0.26	0.07	0.09	0.04
Correct prediction	70%	71%	75%			
Type I error	8%	8%	7%			
Type II error	22%	21%	17%			

problems by reducing incentives to shift risk (see, for example, Boot et al. (1991) and Boot and Thakor (1994)).[31] Similarly, shorter maturities may be useful in addressing information problems by forcing more frequent information disclosure and renegotiation of contract terms (see, for example, Graham et al. (2008) and Ortiz-Molina and Penas (2008)). Hence, in this section we explore whether such compensating mechanisms play a more important role after the introduction of deposit insurance.

We begin by investigating whether the probability of pledging collateral increases systematically after the introduction of deposit insurance. The results are reported in Table 7. Column I presents a specification similar to the baseline model (i.e., with the same set of controls). Surprisingly, after the introduction of deposit insurance, the probability of pledging collateral falls by 12% (a 53% decrease in the incidence of collateral), suggesting that banks do not compensate their increase in risk-taking by increasing collateral requirements.

Next, we investigate the relationship between collateral and risk, both before and after the introduction of deposit insurance, by adding *Subprime* to the specification, and splitting the sample into the two periods (Columns II and III). In both periods *Subprime* loans are more likely to be collateralized

[31] In addition, collateral requirements allow lenders to sort observationally equivalent loan applicants (see, for example, Besanko and Thakor (1987a,b), and Bester (1985)).

than loans with ratings equal to 1, but there is no statistically significant difference in the relative degree of collateralization between the two periods.[32]

A similar exercise is carried out for loan maturity. The results are presented in Column IV (for the entire period), Column V (before deposit insurance) and Column VI (after deposit insurance). We find that loan maturity is not affected by the introduction of deposit insurance—perhaps because maturities in Bolivia are already so short that there is no room for further decrease (the median loan maturity in the sample is only 6 months). In addition, the results in Columns V and VI suggest that before the introduction of deposit insurance *Subprime* loans have higher maturities than the safest rating category, but not afterwards. However, these differences between the two periods are not statistically significant.

All in all, these results suggest that banks do not use other contract terms (such as collateral or maturity) to compensate for their increased risk-taking behavior.

5.4. Bank-level analysis

The use of data on loan initiations and ratings at origination makes it possible to uncover the effect of deposit insurance on *contemporaneous* and *ex-ante* risk-taking. This is the main advantage of the loan-level analysis. A complete assessment of risk-taking, however, requires an ex-post analysis at the portfolio level, since imperfect correlation of loan performance reduces portfolio risk. Hence, we complement the loan-level analysis by examining the traditional bank balance-sheet measure of non-performing loans used in the literature.[33] Controlling for bank fixed effects and macroeconomic factors, we find that the ratio of non-performing loans to total assets (total loans) is systematically higher by about 3.7% (6.7%) after the introduction of deposit insurance—consistent with our previous findings. To save space, these results are not reported in the paper, but are available upon request.

6. Robustness checks

We undertake two additional exercises. First, we add loan-level characteristics to the baseline model of Table 5, controlling for contract type, currency denomination, firm type, industry and region. The results are reported in Column I of Table 7. Even after controlling for these factors, the coefficient of *DI* is positive and statistically significant, suggesting that the increase in risk-taking behavior was not concentrated in a particular industry, region, type of firm, or currency denomination. In terms of economic significance, the effects are similar to those found earlier. Deposit insurance is associated with an increase in the probability of *Subprime* loans by 7.1%, which implies an increase in the incidence of these loans by 64%. Note also that the model's prediction accuracy improves over its counterpart in Table 5.

We perform a similar robustness check for the specifications reported in Table 6. In all cases, introducing additional controls improves the model's predictions accuracy, but leaves the results with respect to our key explanatory variables unchanged. To save on space, these results are not reported in the paper, but are available upon request.

Finally, we also investigate the robustness of our findings with respect to the *Share of Large Deposits* using alternative thresholds. The results are reported in Table 8. In Columns II and III we use a threshold of US$5000 for large depositors, and in Columns IV and V we use a threshold of US$50,000. Consistent with our previous findings (using a US$30,000 cutoff), the *Share of Large Deposits* decreases the probability of issuing *Subprime* loans before the introduction of deposit insurance, but not afterwards.

[32] To test whether the differences are statistically significant we re-estimate the model for the entire sample period allowing for interactions between all right-hand-side variables with the deposit insurance dummy. It should be pointed out, however, that if we estimate the relative change of each subprime rating category with respect to the safest category (i.e., include rating 2, 3, and 4 separately instead of *Subprime*) we find that there is an increase in the relative incidence of collateral for loans with rating equal to 2 as opposed to 1.

[33] See, among others, Gropp and Vesala (2004), Grossman (1992), and Karels and McClatchey (1999).

Table 8
Robustness checks. This table reports estimated Probit coefficients, where the dependent variable is *Subprime*, a dummy variable that equals one if at origination a loan has a credit rating higher than 1, and is equal to zero otherwise. Loans with ratings equal to 5 at origination are not included in the sample. "Other controls" refers to dummy variables for type of contract, currency, industry, and region. In Columns II–V we estimate the specifications in Columns II and III of Table 6 using alternative thresholds for the definition of large depositors: US$5000 or US$50,000, instead of US$30,000 used in Table 6. All bank and macro controls are used with a lag of 1 month. The standard errors of the reported coefficients are clustered at the firm level and are reported between brackets. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

	I All	II *DI* = 0	III *DI* = 1	IV *DI* = 0	V *DI* = 1
Constant	−1.433	10.311***	−10.768*	7.048***	−11.927**
	[1.102]	[2.337]	[5.952]	[1.937]	[5.648]
Deposit insurance dummy	0.360***				
	[0.101]				
Share of large deposits: ⩾ US $ 5000		−5.889***	−0.467		
		[1.395]	[1.563]		
Share of large deposits: ⩾ US $ 50,000				−2.090***	0.724
				[0.478]	[0.598]
Log(Assets)		−1.009**	0.806	−1254***	0.685
		[0.444]	[1.704]	[0.455]	[1.638]
Log(Assets)_Square		0.064*	−0.053	0.084**	−0.043
		[0.037]	[0.157]	[0.037]	[0.151]
Capital ratio		−0.035**	0.006	−0.043***	−0.011
		[0.014]	[0.028]	[0.015]	[0.028]
Non-performing loans ratio		−0.033***	0.049***	−0.034***	0.047***
		[0.012]	[0.014]	[0.012]	[0.015]
Loan-loss reserves ratio		0.030	−0.043*	0.053**	−0.043*
		[0.022]	[0.023]	[0.023]	[0.024]
Profitability		0.009*	0.015	0.010**	0.014
		[0.005]	[0.014]	[0.005]	[0.013]
Liquidity ratio		−0.032***	0.028	−0.026***	0.036*
		[0.009]	[0.021]	[0.009]	[0.022]
Bolivian GDP growth	−0.114***	−0.146***	0.035	−0.150***	0.042
	[0.033]	[0.039]	[0.122]	[0.040]	[0.124]
Bolivian inflation rate	0.015	0.061***	−0.107**	0.064***	−0.119***
	[0.017]	[0.021]	[0.043]	[0.022]	[0.044]
Exchange rate change	−0.706	−2.628*	−0.948	−2.431	−0.867
	[0.598]	[1.526]	[0.670]	[1.505]	[0.660]
Market interest rate	0.028	−0.044***	−0.028*	−0.045***	−0.029*
	[0.017]	[0.017]	[0.016]	[0.017]	[0.017]
Country risk indicator	0.015	0.004	0.109**	0.003	0.118**
	[0.014]	[0.016]	[0.050]	[0.016]	[0.051]
Aggregate non-performing loans ratio	−0.058**				
	[0.027]				
Trend	−0.012**	−0.012*	−0.002	−0.015**	0.002
	[0.006]	[0.007]	[0.011]	[0.007]	[0.011]
Herfindahl–Hirschman Index	−1.722	−1.418	−0.632	−1.388	−0.679
	[1.160]	[0.967]	[0.661]	[0.973]	[0.653]
Bank fixed effects and other controls	Yes	No	No	No	No
Number of observations	31,506	20,087	11,215	20,087	11,215
Pseudo *R*-square	0.08	0.04	0.02	0.04	0.03
Correct predictions	64%	58%	57%	58%	57%
Type I error	32%	33%	40%	33%	41%
Type II error	33%	38%	40%	38%	40%

7. Conclusions

We examine how the introduction of deposit insurance affects the credit quality of bank loans. The analysis focuses on the case of an emerging economy that experienced a dramatic regulatory change in 2001, from a system with ambiguous implicit guarantees to a system with partial deposit insurance, which covers a fraction of all deposits, independent of their size. Our main findings indicate that the

introduction of deposit insurance led to an increase in the probability of a bank originating a subprime loan. Our results also suggest that banks do not increase collateral requirements or decrease loan maturity to compensate for the extra risk.

The results of the cross-sectional analysis are also consistent with this interpretation. Banks with a high share of large depositors take less risk before the introduction of deposit insurance, but the effect disappears after the introduction of a system that provided all depositors with generous explicit guarantees, suggesting that the increase in risk-taking is due to a decrease in market discipline. Similarly, banks that benefited the most from the explicit guarantee (i.e., banks that experienced the largest drop in the cost of deposits following the introduction of deposit insurance) are those that take more risk in the second period. The results also suggest that differences between large (too-big-to-fail) and small banks diminished in the post-deposit-insurance period.

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