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Borrowing Culture and Debt Relief: Evidence from a Policy Experiment

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September 2015

Abstract

The present paper investigates the effects of a large-scale debt relief program for delinquent borrowers on ex post loan repayment behavior of the relief recipients and on their access to new credit. We use audited transactions data of the loan accounts of a large sample of borrowers before and after a nation-wide rural debt waiver program undertaken by the Indian government in 2008, one of the largest such programs in history. Program eligibility cut-off based on landholdings of the farmers in our sample allows us to employ robust regression discontinuity designs as well as difference-in-difference methodologies in order to causally estimate the impact of the waiver program. We find no evidence that unconditional debt waiver leads to improvement in ex post behavior of the waiver beneficiaries. Moral hazard on the part of the borrowers caused by expectations of more waivers in future explains our findings. Further, we find indirect evidence that, rationally anticipating adverse borrower behavior, the loan officers ration credit, resulting in ex-ante inefficiency in credit markets. In order to disentangle demand and supply side factors in credit supply, we use unique loan officer level data and exploit mandatory loan officer rotation policy in Indian public sector banks. In sum, our work provides empirical evidence on both hidden information (ex ante selection based on unobserved anticipated efforts) and hidden action (ex post incentive effects) implications of a large government-initiated debt relief program. In the case of an unconditional debt waiver program, both types of evidence are negative.

Key Words: bank credit; borrowing culture; debt relief; credit market interventions.
JEL Classification: G21, O2, Q14.

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September 15, 2015

Abstract

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*Sankar De is from Shiv Nadar University, India. Prasanna Tantri is from Indian School of Business, India. The authors thank an Indian public sector bank for providing the loan account level data. They also thank Michael Gordy and Raghuram Rajan for encouragement at an earlier stage of the project, and conference and seminar participants at ISI Delhi, Emerging Market Finance conference at IGIDR, and Journal of Financial Stability conference. The usual disclaimer applies.

I Introduction

Government interventions in credit markets in the form of large-scale debt relief programs for delinquent borrowers are increasingly common, especially in rural credit markets in emerging economies. Some recent examples include a USD 3 billion farm loan bailout in Thailand and a USD 10 billion household debt restructuring program in Brazil (Giné and Kanz (2013)). However, the current state of knowledge about the implications of such interventions for the efficiency of the credit markets following the programs in question is limited. Important efficiency issues, such as the creditors' ex ante response to new loan requests from relief beneficiaries as well as ex post efficiency issues including repayment behavior of the beneficiaries on new loans are under-researched. Lack of reliable loan accounts data for retail borrowers has been a hindrance to empirical investigations. More importantly, the discussions in the existing literature, such as there are, have mostly taken place in the context of an advanced economy, usually the USA, with much of the recent empirical work focussing on relief programs surrounding the 2008-09 financial crisis (see, for example, Mayer, Morrison, Piskorski, and Gupta (2011); Agarwal, Amromin, Ben-David, Chomsisengphet, Piskorski, and Seru (2013)). However, ex-post borrower behavior and access to new credit are likely to be more serious concerns in an emerging economy where debt contract enforcement is typically imperfect and loan recovery uncertain.

The present paper attempts to fill in the gaps in the existing literature noted above. Our setting is the rural credit market in India. Typical of many emerging economies, in this market regular access to credit is very important for the farmers. They need credit for their operating expenses (seeds, fertilizers etc.) during the havesting season and are expected to pay off their debt from the proceeds of the harvest. The borrowing and repayment cycle is repeated each year. In this market, the farmers borrow from commercial banks at a government-mandated subsidized rate of interest and from informal sources such as private moneylenders at a substantially higher rate, debt contract enforcement is imperfect, and political interventions in the credit market can happen even in normal states of the economy. In this setting, the paper attempts to answer the following specific questions:

a. What are the implication of a large-scale debt relief program for future loan repayment behavior of both relief beneficiaries and comparable non beneficiaries? A related empirical study by Giné and Kanz (2013)investigates the effects only for waiver beneficiaries. It also differs from our study in other important respects. It uses aggregate district-level loan data and is, therefore, restricted to district-level outcomes. By contrast, we examine audited transactions data and other relevant information for the loan accounts of a large sample of individual borrowers for a sufficiently long period before and after the program. Hence, we are able not only to track changes in their debt repayment

behavior but also to verify whether the program qualification rules were properly satisfied for each borrower in the sample. A major concern with emerging market studies is data authenticity. Our approach addresses that concern fully. Another related study by Kanz (2011) focuses on real outcomes such as productivity and investments using survey data. Our line of inquiry also differs significantly from that of Mukherjee, Subramanian, and Tantri (2014), who investigate whether the impact of the debt relief programs is different for distressed borrowers who have experienced adverse weather shocks and non-distressed borrowers. We consider credit market efficiency implications of the program after controlling for weather shocks.

b. What is the impact of a debt relief program on future access to credit for relief beneficiaries? This question has not been examined before in the context of a large government-funded debt relief program. In a broader context, existing empirical evidence on ex ante selection by creditors based on unobserved but anticipated efforts of borrowers is thin (Chiappori and Salanie (2000)). The question, however, is important. Reduced credit access may adversely impact inter-temporal consumption smoothing, especially given that the rural borrowers need regular access to credit, and hence nullify the benefits provided by one-time debt relief. We note here that a sizable recent literature has looked at credit market impact of debt relief in contexts that are very different from ours, such as individual bankruptcy (Cohen-Cole, Duygan-Bump, and Montoriol-Garriga (2009); Chatterjee, Corbae, Nakajima, and Ríos-Rull (2007); Athreya (2002); Livshits, MacGee, and Tertilt (2007)). It has also been observed that such debt relief programs lead to reduced credit access and increased interest rate spreads in general (Han and Li (2011); Cohen-Cole, Duygan-Bump, and Montoriol-Garriga (2009)). However, the possibility that certain beneficiaries may self select into such programs gives rise to endogeneity concerns (Dobbie (2013)). Another branch of this literature examines borrowers' reaction to government-induced modifications of existing home loan mortgages in the USA, though no relief is directly provided by the government (Agarwal, Amromin, Ben-David, Chomsisengphet, Piskorski, and Seru (2013); Kroszner (1999); Rucker and Alston (1987)).

In sum, our agenda in this paper is to empirically examine both the hidden information (ex ante selection based on unobserved anticipated effort) as well as hidden action (ex post incentive effects) implications of a large-scale debt relief program. Separating the two effects in practice is a challenging task (Karlan and Zinman (2009)). For our tests, we use the recorded debt repayment data for an extensive sample of borrowers and lending decisions of creditors preceding and following a very large debt waiver program in India. The program was officially named the Agricultural Debt Waiver and Debt Relief Scheme (ADWDRS) for Small and Marginal Farmers. Ours is the first paper to use loan level data to examine the economic implications of the ADWDRS program, though Kanz (2011); Giné and Kanz (2013); Mukherjee, Subramanian, and Tantri (2014) also use the same

program in their studies. The program was announced by the Indian finance minister on February 29, 2008, as part of the annual budget for the financial year 2008-09,[1] the last budget before the national elections in 2009.

In section III of this paper, we discuss the key features of the program. We note here briefly that the program covered overdue farm loans owed to commercial banks at the end of 2007. "Small and marginal farmers" defined for the purpose of the program as farmers with landholdings of 2 hectares or less, were eligible for a full (100%) waiver of overdue debt (henceforth referred to as "full waiver" farmers), while the "the other farmers" defined as those with more than 2 hectares (henceforth referred to as "partial waiver" farmers), qualified for partial (25%) loan relief conditional on repayment of the remaining 75%. It is one of the largest debt relief programs in history. It should be noted that the program clearly stipulated that the farmers who had their loans waived should not be discriminated against in future loan decisions though they had defaulted on their last loan. The intention was to let the previously debt-ridden farmers, with their balance sheet cleaned up, remain eligible for new credit and be able to carry on their agricultural activities as before. The program ultimately covered a total of 716.8 billion Indian rupees (INR) in overdue farm debt owed to the commercial banks and an estimated 36 million farmers. The cost of the program was about USD 14.4 billion at the then prevailing rate of exchange and amounted to 1.3% of the Indian GDP. The waiver program constituted a massive transfer from the exchequer to the farmers. The banks that wrote off the loans were reimbursed in full by the government. Apart from its large scope and importance, other features of the ADWDRS program make it an appropriate testing ground for the present study. Further, the program was a one-off initiative that left the formal banking and regulatory environment unchanged, unlike many relief programs that are accompanied by institutional and regulatory changes. The situation allows the researchers to cleanly isolate the effects of the bailout package on the variables of interest and helps identification.

Our sample consists of panel data of complete audited transaction records for twelve thousand plus agricultural borrower accounts with a public sector bank in India over the period October 2005 - May 2012. Of them 6662 received partial or full waiver of their overdue debt under the ADWDRS program. Our data and setting are particularly suitable for the goals of this paper. The data-set contains landholding information for the full waiver and partial waiver beneficiaries. The transactions records for the accounts include not only the details of each transaction but also a sufficiently detailed description of the exact nature of the transaction. With the help of the description and other variables, we are able to determine the date on which a loan was given, amount of the loan, the date of repayment, if the loan was overdue and the duration for which it was overdue. Section IV below of this paper presents a fuller description of the data. The announcement of the

[1]The Indian financial year runs from April to March.

debt waiver program (February 29, 2008) was right in the middle of the sample period, giving us a sufficiently long period before as well as after the program to observe and compare the borrowing behavior of the farmers in our sample. Our dataset also contains information on rotation of the loan officers at the branches where the loans were given. Public sector banks in India have a mandatory rotation policy. The information enables us to identify whether it is a new loan officer who considers new loan requests from a waiver beneficiary in the post-waiver period or the same loan officer who approved the loan that defaulted before the program announcement. We exploit the information in designing tests for access to credit in the post-waiver period.

As partial and full-waiver farmers are the two groups of borrowers that defaulted on the last loan before the waiver program, in the interest of clean identification we focus on the two groups in the present study. Though the borrowers on both sides of the two hectares mark are defaulters, by design the treatment, that is the magnitude of the debt relief, for a borrower depends on which side of the cut-off point the borrower is. We recognize that the entire samples of full-waiver and partial-waiver beneficiaries cannot be objectively compared directly, as partial waiver beneficiaries are systematically larger farmers and may well differ from the other group in other dimensions related to largeness, such as loan size.

In terms of choice of appropriate empirical methodology for our tests, the nature of the program, the qualification criterion based on a landholding cut-off, and the granularity of our data make for an ideal setting for application of regression discontinuity (RD) design. As Lee and Lemieux (2010) demonstrate, if the agents cannot "precisely" manipulate the running variable around the discontinuity threshold with a view to self-selection into the preferred side of the threshold, then the variation in the treatment around the threshold is "as good as randomized" in a RD design. Such self selection is unlikely in our setting. First, as described above, the qualification into the program depended on the size of the land possessed by a farmer. Land, by its very nature, is not an infinitely divisible asset. More importantly, farmers organize their land into fields of various sizes, making it difficult to cut out a small piece from the field in order to slip into a smaller group. Secondly, though the waiver program was announced on February 29, 2008, the waiver was awarded only to defaulters as of December 31, 2007. Given that crop loans in India typically have a tenure of one year, the eligible loans should have been borrowed, and landholdings pledged as collateral, a good fourteen months before the waiver announcement. Correct anticipation of the program and consequent self selection that far back would be inconceivable. In fact, judging by all available evidence, the program was unanticipated before its announcement. It was the first nation-wide agricultural debt relief program in India after 1990.[2] The program in 1990 did not

[2]Source:http://timesofindia.indiatimes.com/city/chandigarh/INLD-says-Devi-Lal-had-initiated-reforms-for-aam-aadmi-long-ago/articleshow/28408304.cms

precede an election. Five national elections were held in the intervening period 1990 - 2008. No large scale debt waiver preceded any of those elections either. Though it had been recognized in policy circles for some time that rural indebtedness was a serious problem in India, the years preceding the program experienced normal annual rainfall and increasing food grains production. In particular, the year 2007 was a good year in terms of rainfall as well as agricultural productionMukherjee, Subramanian, and Tantri (2014). Finally, we have conducted McCrary (2008) tests to check for evidence of bunching of the borrowers below the threshold of 2 hectares of landholding. We find no such evidence (please section VI of this paper).

Our RD tests between full waiver beneficiaries (treated group) and partial waiver beneficiaries (control group) use land as the running variable and two hectares as the cut-off point. We make use of recent advances in RD methodology, and employ robust RD design developed by Calonico, Cattaneo, and Titiunik (2014). Their method recognizes that conventional RD estimators make bandwidth choices that lead to "biases in the distributional approximation of the estimators"The method first corrects for bias in the RD estimator by re-centering the t-statistics. In order to improve the distributional approximation after bias correction, t-statistics are re-scaled. Following them, we report our results separately for conventional, bias-corrected, and robust (t-statistics re-scaled) RD designs. We execute other improvements as well. As pointed out by Lee and Lemieux (2010), a serious limitation of the standard RD designs is the assumption that all other covariates in the test model besides the running variable which could potentially influence outcomes are continuous around the discontinuity threshold. This assumption needs verification. In order to control for the impact of other covariates on the dependent variable, we use the following two methods; First, following Lee and Lemieux (2010) we first estimate a regression of the dependent variable on the other covariates excluding the running variable. We control for possible dissimilarities between the two groups with respect to relevant observable characteristics, including individual-level characteristics, such as loan amount and credit history, and district-level characteristics including rainfall, agricultural production, and credit flow into the district. We also employ a battery of fixed effects alternatively at the level of a borrower, bank branch, month, year, branch*month, brnch*year etc. to control for unobservable time invariant as well as time varying factors. Using the residuals from the above regression as the dependent variable, we then estimate robust RD coefficients. In what follows we call this approach residualized RD design. Second, we employ a conventional difference-in-difference approach for a subset of full waiver and partial waiver farmers with landholdings within a narrow band around two hectares threshold. Here also we use the same control variables and fixed effects noted above.

In the first part of this paper, we consider the impact of the waiver program on loan repayment in the post-waiver period. In our main tests we use default, a dummy that

takes the value of 1 if the loan under consideration remains outstanding beyond the loan maturity period (365 days for a typical crop loan in India) as the dependent variable. We test the robustness of our results by using number of overdue days (Visaria (2009)) and total number of days a loan is outstanding as dependent variables in separate tests. Using the RD designs noted above, we find that the difference in the probability of default in the post-waiver period between full-waiver and comparable partial-waiver farmers around the two hectares mark is statistically indistinguishable from zero. The results using the other two dependent variables are very similar.

What explains our much verified finding that full-waiver and partial-waiver borrowers with similar landholdings but very asymmetric treatments under the ADWDRS program exhibit similar loan repayment behavior in the post waiver period? As we have noted above, the program was unanticipated. The average borrower had no expectation of a bailout before the program, and positive expectations afterwards of similar bailouts in future, especially given that the program was implemented in a time of normal rural economic conditions. The result is moral hazard on the part of the borrowers inducing strategic default. Please note that the intuition behind this result is very general, and does not require any special structure on the borrowers' beliefs. As long as there was no (or less) expectation of debt relief before the 2008 program (since the program was unexpected), any positive probability, however small (or slightly higher than before) of another debt relief in the post-waiver period (conditional on the 2008 relief having happened), is sufficient to generate moral hazard. Our findings indicate ex post adverse incentive effects. We also rule out a few possible alternative explanations for our findings.

The second part of this paper deals with the impact of the waiver program on ex-ante efficiency of credit markets as reflected in access to credit in the post-waiver period. Bolton and Rosenthal (2002) consider the possibility that anticipated political interventions in private debt contracts may induce lenders to ration credit. However, if an enlightened political system only permits interventions conditional on adverse shocks to the economy, ex ante efficiency may even improve by completing debt contracts which are typically incomplete with respect to outcomes in bad states. It follows that in our setting, where the waiver program was implemented in a normal state of the economy, credit rationing is likely to follow. To test this proposition, we exploit the special features of our loan officers rotation data. Using the probability of no loan in the post-waiver period for a pre-waiver borrower as the dependent variable, we design RD tests between full waiver and partial waiver beneficiaries with land as the running variable separately for bank branches that experience a loan officer rotation shortly after the program announcement and branches that do not. We find that full waiver beneficiaries have a 34.6% higher chance of not having a loan and approximately INR 38,000 less in loan amount in the post waiver period than partial-waiver beneficiaries with comparable landholdings in bank branches with a new loan officer. We perform falsification tests in order to en-

sure that the above results are not driven learning effect or general risk aversion of the new loan officer unconnected with waiver. The observed decline in loan size is much higher than the median loan size for the full sample of borrowers. However, in branches where there was no rotation, there is no statistically significant difference between the two groups.

We believe that the evidence indicates ex ante adverse selection and credit rationing. Though it is very hard to disentangle supply effects from demand effects in data, if the results were demand-driven we would observe lower loan demand for full waiver borrowers in both types of branches, not just the branches that experience loan officer rotation. In other words, we make the reasonable identifying assumption that the difference in loan demand between full waiver and partial waiver farmers at the margin (near the cut-off of 2 hectares) is unlikely to be correlated with the continuation or rotation of the loan officers who served before the waiver. Therefore, any observed difference in loan amount is supply-induced. The same identification strategy also disposes of some other arguments for low loan demand, such as stigma in borrowing, fixed costs of accessing formal finance, transition to other banks etc. Finally, as discussed in Section II below , agricultural loans in India are available up to a point at a steep discount even to the risk free rate. The discount is as high as 450 basis points. This fact further weakens demand-based explanations. As for an explanation why supply-induced fall in loan amount is not observed in bank branches where the same loan officers continue, we note that the reported results for those branches potentially reflect two confounding factors which are absent in the case of the former branches. First, loan officers in Indian public sector banks are known to evergreen bad loans regularly in order to avoid booking defaults with their associated negative consequences, including investigations for corruption (Banerjee and Duflo (2014)). Employed as an alternative to rationing potentially bad loans, such evergreening may actually increase in the presence of moral hazard induced by the waiver. Second, continuing loan officers are likely to posses soft information about the borrowers and also have access to informal networks(Fisman, Paravisini, and Vig (2012), especially in rural economies. which may help them enforce loan contracts even in the presence of increased moral hazard. By contrast, in branches where a new loan officer takes charge both factors are missing. The new loan officer neither possesses soft information nor has incentives to evergreen loans given by her predecessor. In fact, it has been shown that the incoming loan officer has incentives to expose the outgoing loan officer (Hertzberg, Liberti, and Paravisini (2010)).

Finally, why should full waiver beneficiaries in a branch with a new loan officer face credit rationing, while the average partial waiver beneficiary in the same branch does not? As we have noted above, a new loan officer has only hard information to go by, including credit history and landholdings. In the present case, credit history for the average borrower in the two groups in our sample is pretty similar, both groups having

defaulted on the last loan before the program, while landholdings are also similar by design. For the loan officer, what makes the two groups different is her anticipation how the two groups will behave in the event of a future bailout program. She rationally anticipates that the next bailout will again be more favorable to the smaller group, as bailout programs typically are. In that event, the current full waiver group will become even more susceptible to moral hazard and strategic behavior than the other group. Accordingly, she resorts to ex ante selection to limit the possible damage.

The arguments and test results in support of credit rationing, sketched briefly here, are discussed more fully in section VII of the paper below. Though indirect, Our evidence on credit rationing is clear and consistent across tests. Let us note that the evidence is also consistent with the evidence on ex post adverse incentive effects in the case of full waiver beneficiaries documented before. In this part of the paper we have gone further. We have presented suggestive evidence that the loan officers actually try to limit ex post negative behavior of full waiver borrowers by resorting to ex ante selection and credit rationing. In other words, the observed negative ex post effects would be stronger in the absence of such selection. The evidence presented in the two parts of this paper adds up nicely to support the central theme of the paper, namely that unconditional government debt relief programs lead to both ex post adverse incentive effects and ex ante adverse selection effects.

In the final analysis, our work provides empirical evidence on both hidden information (ex ante selection based on unobserved but anticipated effort) and hidden action (ex post incentive effects) implications of a large government-initiated debt relief program. In the case of an unconditional debt waiver program, both types of evidence are negative. As Karlan and Zinman (2009) point out, hidden information is always harder to identify in practice. Accordingly, our evidence on ex ante selection by the bankers is of necessity indirect. However, given that empirical evidence on the existence and magnitude of specific information frictions in credit markets is thin (Chiappori and Salenie, 2000), our indirect evidence makes a useful contribution to the existing literature.

The paper proceeds in the following manner. Section II describes the relevant institutional background. Section III describes the key features of the ADWDRS program in India. Section IV describes the data and variables used in our tests. Section V presents our empirical methodology and the test results. In section VI, we address a couple of possible concerns about our results. Section VII presents our evidence on credit rationing. Section VIII presents our conclusions.

II Institutional Background

In this section we briefly describe the Indian banking system and incentives system applicable to loan officers in government owned banks in India. As mentioned above, the

bank from which we obtained our data is a government-owned bank.

II.A Indian Banking System

Indian banking system comprises four types of banks; a. government-owned banks (also known as public sector banks); b. Old private sector banks; c. new private sector banks; and d. foreign banks. All public sector banks except State Bank of India[3] were created by nationalising the then existing large private sector banks in two phases: 1969 and 1980 (Cole (2009)). All public sector banks are listed and have significant minority stake. Government stake in public sector banks varies between 55% and 85%.[4] Government owned banks account for more than 73% of total banking credit.[5] The banks that existed at the time of nationalisation but were not nationalised are known as old private sector banks. India embarked on the path of economic and financial liberalisation in 1991. Legal framework was suitably amended in 1993 to allow new private sector banks. Banks that are subsidiaries of large foreign owned multinational banks are known as foreign banks. All banks in India are regulated by the Reserve Bank of India (RBI)-Indian central bank. RBI has developed a reputation as a professional and independent regulator.

II.B Subsidised Agricultural Lending

All banks in India are required to allocate at least 18% of their total credit to agriculture (Cole (2009)) under the priority sector lending guidelines issued by the RBI. Agricultural loans below INR 300,000 carry a fixed rate of 7% per anum.[6] The farmers who repay their loans in time get a concession of 3% per anum.[7] Thus the effective rate of interest on agricultural loans is 4%. According to data compiled by the RBI, the average lending rate charged by public sector banks in India is 12.75%.[8] The risk free rate in India at the time of the AWORDS program was 8.5%. Thus agricultural loans are offered at substantial discounts to even the risk free rate.

II.C Loan Officer Incentives in Public Sector Banks

The employees of the government-owned banks are public servants in India. Seniority in job is the most important determinant of their career progression. There

[3]State Bank of India is the largest bank in India. It was created out of Imperial Bank of India that existed prior to Indian independence from the British in 1947. Source: Reserve Bank of India

[4]Table with Government stakes in public sector banks, http://financialservices.gov.in/banking/Shareholding

[5]Source:http://rbidocs.rbi.org.in/rdocs/PublicationReport/Pdfs/BCF090514FR.pdf

[6]This is a Government mandate. Source: http://farmer.gov.in/shortloan.html

[7]Government of India bears this subsidy. Source: http://farmer.gov.in/shortloan.html

[8]Source: Reserve Bank of India, http://rbi.org.in/rbi-sourcefiles/lendingrate/LendingRates.aspx

are hardly any performance-linked positive incentives**?**. Being public servants, the employees of government-owned banks come under the purview of the Central Vigilance Commission(CVC)- an agency set up by the Federal Government as an anti corruption watchdog. Existing research indicates that fear of prosecution by the CVC makes the loan officers in a public sector bank rigid and conservative (Banerjee, Cole, and Duflo (2008)). Given this institutional background, it is unlikely that loan officers, with the intention of maximising profits, lend to borrowers with bad credit history. It has also been pointed out that loan officers of Indian public sector banks resort to ever-greening in order to avoid booking of defaults (Banerjee and Duflo (2014)). The banks follow a mandatory rotation policy of loan officers in order to avoid collusion. A loan officer is transferred after she spends 3 years in a branch. Such transfers have no relationship to business performance of the branch.

III Debt Relief Program for Small and Marginal Farmers (2008) In India

Farmers indebtedness in India is an old problem, almost as old as Indian agriculture itself, though the problem was increasing in magnitude over time. Unpredictable rainfall, small landholdings, and high interest rates on loans from private money lenders have been cited as some of the reasons that had pushed rural farmers into unsustainable levels of debt Mukherjee, Subramanian, and Tantri (2014). While the rest of the Indian economy was growing at an average annual rate of 8% in the early years of the present century, agricultural sector, by far the largest employer of the working age population in the country, grew at an anemic 2.3% rate. To limit the magnitude of the farm debt problem, from time to time the Indian government had attempted various measures, such as highly subsidized priority sector agricultural loans, and also set up committees to suggest measures. The last such committee before the AWDRDS program of 2008 was the Expert Committee on Rural Indebtedness with a sweeping mandate: to look into the problems of agricultural indebtedness in its totality and to suggest measures to provide relief to farmers across the country. The committee submitted its report in July 2007. Two important recommendations of the committee were a government fund specifically set up to provide long-term bank loans to farmers, in an effort to limit high-interest loans from private moneylenders, and special relief packages for a 100 districts, out of a total of 640 in India, that have been identified as low land productivity areas. Notably, the committee did not recommend a waiver, unconditional or otherwise, of overdue commercial bank loans.

Curiously, the debt relief program of 2008 was launched in a normal state of the rural economy. The years immediately preceding the program experienced normal rainfall

and, in fact, increasing agricultural productivity and increasing food grains production. In particular, 2007 was a better than normal year in terms of those indicators Mukherjee, Subramanian, and Tantri (2014). The fact that the program was launched in a normal state of the economy has an important implication for our analysis.

The program covered formal agricultural debt issued by commercial and cooperative banks. The types of debt included crop loans, investment loans for direct agricultural purposes or purposes allied to agriculture, and agricultural debt restructured under prior debt restructuring programs. Over a period of time the government compensated the banks in full for the loans written off under the program. Loans from moneylenders and other informal sources, and loans taken for non-agricultural purposes, were not included in the program.

To qualify for debt relief, a loan had to be overdue or restructured as of December 31, 2007 (well prior to the program announcement on February 29, 2008). It is important to note that the status of the last loan before waiver was the determining factor for waiver.Small and marginal farmers, defined for the purpose of the program as farmers with landholdings of 2 hectares or less, were eligible for a full (100%) waiver, while the other farmers, defined as those with more than 2 hectares, qualified for partial (25%) loan relief conditional on repayment of the remaining 75%. The implementation of the program began on June 30, 2008

IV Data and Summary Statistics

For all empirical work in this paper we use a loan account level dataset obtained from an Indian public sector bank. Established over seventy years ago, the bank has a pan-India presence and operates more than a thousand branches.

IV.A Transaction Records

The original dataset includes account level data for 12,105 farmers who are customers of the bank and had received crop loan. However, information on landholding is critical for all our tests. Therefore our final sample includes only those borrowers whose landholding information is available. There are 6,662 such borrowers in our sample who received a total of 19,408 loans during the period October 2005 - May 2012. The farmers belong to 4 districts of the state of Andhra Pradesh[9] in India: Karimnagar, Khammam, Mehboobnagar, and Medak. Only two of the 4 districts share a common border with each other. All the four districts share a common border with at least one other state. The bank has a total of 9 branches in those districts. Andhra Pradesh is known as the

[9]Currently the erstwhile state of Andhra Pradesh is divided into two states: Telangana and Andhra Pradesh

rice bowl of India. In most cases, the crop under consideration is rice. As typical of agricultural credit, the loans are short term loans, typically payable within the year. We have obtained sample loan contracts for rice loans from the bank. The contract clearly states that the loan repayment is due after a year. These loans fall under priority sector guidelines issued by the RBI and carry a subsidized interest rate. The loans are mostly fully collateralized, with land and standing crops being the standard collateral assets. A state level bankers committee, comprising the state government representatives and senior bankers in the state, issues guidelines regarding collateral requirements and the amount of loan to be given per hectare of land for different crops. These guidelines, although not mandatory, are generally adhered to by banks.

Our sample is not a random sample and includes all farmers who are customers of the bank in the 9 branches. The transactions records of the farmers in the sample include the date of each transaction, a description of the transaction, type of the transaction (debit or credit), transaction amount, account balance before the transaction and after. The description of the transaction is sufficiently detailed for us to understand the exact nature of the transaction. With the help of the description and other variables, we are able to determine when a particular loan was taken, the amount of the loan, interest and other charges and when the loan was repaid and how long was the payment period.

The loan waiver scheme required the banks to publish detailed information about the beneficiaries of the program on their notice boards and websites. The information included size of their land holding.

IV.B Loan Officer data

We also collected data on the tenure of each loan officer in all the 9 branches of the bank during our sample period. The data includes the exact date when a loan officer takes charge in a particular branch as well as the date on which he demits office pursuant to job rotation. In total, we have information about 27 loan officers. It is important to note that all the branches we collected data from are small branches located in rural areas. The branches consist of a branch manager and other supporting staff. The branch manager is authorised to take decision on loans upto INR 0.65 million, which is nearly 20 times larger than a typical loan in our sample. For the purpose of this study, each branch manager is the loan officer at the branch.

IV.C Other Data

We have collected data on annual production of food grains for the districts in question during the sample period. Rice was by far the most important crop while wheat, ragi and jowar were also cultivated. The other district-level data we use in our tests are annual

rainfall and annual bank credit flow into the district. The following chart lists the other data and their sources.

IV.D Summary Statistics

Table 2A presents the summary statistics of the data on borrower accounts with loan and land information in our sample

Table 2A About here

We classify the 6,662 farmers in our final sample with landholding information into two categories based on the benefits they received from the debt waiver scheme. Full-waiver farmers are those who have 2 hectares of land or less pledged as collateral, and had overdue farm loan on the cut-off date. Partial-waiver farmers are those who had more than 2 hectares land pledged and had overdue credit on the critical date. They qualified for partial (25%) loan relief conditional on repayment of the remaining 75% within a year. 4,556 farmers in our sample fall under the full waiver category, and 2,106 farmers under the partial waiver category. The full-waiver group in the sample have a total of 13,438 loans during the sample period. 5,489 of those loans were taken in the pre-waiver period and the remaining 7,949 loans in the post waiver period. The partial-waiver group in the sample have a total of 5,970 loans during the sample period, 2,601 of them in the pre-waiver period and the remaining 3,369 loans in the post waiver period.

We provide summary data pertaining to land and loans in Table 2B.

Table 2B About here

As mentioned above, we have land holding information for 6.662 farmers in full-waiver and partial-waiver groups. The average (median) landholding for the entire sample 1.32 (2.44) hectares. This table shows that the farmers in our sample are indeed small. As expected, the average (median) land holding of the full-waiver farmers is much smaller- 1 (1) - hectare than that of the partial-waiver farmers- 5.65 (3.01)- hectares.

From the table, the average(median) loan amount for the sample during the pre waiver period is INR 34,351(25,000). The number increases to INR 42,077(30,000) in the post waive period. Please note that these are nominal numbers and the increase could be partly due to inflation. The average (median) loan amount for the full waiver beneficiaries increases from is INR 25,133 (18,000) in the pre-waiver period to INR 32,520(25,000) in the post waiver period. Similarly, for partial waiver beneficiaries, the average (median) loan amount increases from INR 53,803(44,000) to INR 66,624 (51,471). We also report summary data relating to amount of loan outstanding just before the waiver program. The amount stands at an average(median) of INR 22,710 (20,277) for full-waiver group and INR 43,451(42,744) for the partial-waiver group. Once again, the numbers are

higher for the partial-waiver group. It is clear from the table that partial-waiver farmers are systematically larger than the full-waiver group in terms of landholdings, and other critical parameters related to landholdings including loan amount and loan outstanding. Landholdings and value of crop standing on land, which again depends on size of landholdings, are used as collateral for agricultural loans in India. This observation influences our empirical strategy.

V Evidence on Ex-post Incentive Effects for Borrowers

The AWDRDS program provides us with two groups of borrowers who received very different levels of treatment, but are similar in terms of credit history, both groups having defaulted on the last loan before the waiver. However, we have noted in the preceding section that the partial-waiver group is systematically larger in terms of landholdings and other critical variables related to landholdings including average loan amount and loan outstanding before the waiver. However, farmers very close to the two-hectare landholding cut-off on either side are likely to be similar not only in terms of those parameters but also other observable and unobservable characteristics relevant to loan repayment decisions.

V.A Robust regression discontinuity results

As we have noted in the introduction, the nature of the AWORDS program, the qualification criterion based on a landholding cut-off, and the granularity of our data make for an ideal setting for application of RD design using size of landholdings as the running variable. We have also noted that the exogenous nature of the event and the nature of the running variable makes self selection by borrowers difficult. We use robust RD designs developed by Calonico, Cattaneo, and Titiunik (2014). The method recognises the fact that the polynomial estimators routinely employed in RD designs are extremely sensitive to the specific bandwidths employed. Calonico, Cattaneo, and Titiunik (2014) show that both conventional RD estimators as well as recently developed nonparametric local polynomial estimators make bandwidth choices that lead to "bias in the distributional approximation of the estimator"Ċalonico et al (2014) first bias-correct the RD estimators by re-centering the t-statistics. This leads to their bias-corrected estimators. They also note that "low quality " distributional approximations are used in the literature. They devise a novel method to calculate standard errors which accounts for the additional variability introduced as a result of the low quality. They name them robust standard errors. We estimate conventional, bias corrected, and robust RD estimates, and report

them separately. For inferences we rely on robust estimators. Our bandwidth selection is based on Imbens and Kalyanaraman (2011).

The results of our RD tests are reported Table 3 below.

Table 3 about here

Each line of data in the table represents a loan (i) borrowed by a farmer (j) from a bank branch k during time (t). We restrict our sample to loans in the post-waiver period. In column 1, the dependent variable is Default, a dummy variable that takes a value of 1 in case of a default, and 0 otherwise. We use number of overdue days as the dependent variable in column 2 and the total number of days a loan is outstanding as the dependent variable in column 3. We report estimators for RD designs using robust standard errors, bias-corrected standard errors, and conventional standard errors in the first, second, and third rows respectively. The estimates reported in columns 1, 2, and 3 corresponding to a specific RD design represent the differential impact of the waiver program between the partial waiver group (on the right side of the discontinuity threshold) and the full waiver group (on the left side). All subsequent tables in this paper also follow this pattern.

The purpose of the above tests is to understand the overall impact of the debt waiver program on loan repayment. If the debt waiver pulls the borrowers out of their poverty traps and allows them to access new loans for productive investments using their freed-up collateral, the default rate in the post-waiver,period should be lower for the full-waiver group than the partial-waiver group at the margin. On the other hand, if these benefits are offset by adverse incentives arising from expectations of future loan waivers and do not lead to any increase in productive investments (Kanz (2011)), then we will not observe any difference in loan repayment behavior between the two groups.

It is clear from columns 1, 2 and 3 of row 1 that there is no statistically significant difference between partial waiver and full waiver groups in terms of default rates, number of overdue days, or the number of days a loan remains outstanding. The treatment seems to have had no differential impact on the loan repayment behaviour of the two groups of waiver beneficiaries regardless of the method employed to measure the impact.

V.B Concern with RD design: Discontinuities in covariates

As noted in the introduction, a major limitation of standard RD designs is the underlying assumption that other covariates that can potentially influence the dependent variable significantly do not jump around the cut-off. Granularity of our data allows us to control for the impact of other economic variables that may vary at the loan, farmer, branch or district level. The covariables include loan amount, loan outstanding, credit history, district-level rain fall and agricultural production etc. We are also able to include various time invariant and time varying fixed effects. This is important to control for the possibility of correlated district level shocks. A number of state and district admin-

istrations announce social sector schemes from time to time which impact the economic status of farmers. In order to incorporate them in our Rd designs, we use the residuals approach suggested in Lee and Lemieux (2010). We compute the residuals by regressing the dependent variables on covariates other than the running variables, and then use the residuals to run our main tests. To compute the residuals, we estimate the following regression equation;

$$Y_{ijkt} = \beta_0 + \beta_{ijkt} + \beta_{jkt} + \beta_{kt} + \gamma X_t + \varepsilon_{ij}, \tag{1}$$

The dependent variable again is again Default, a dummy variable that takes the value of 1 if a farmer i, who borrowed from branch k, defaults on a loan j at time t. The Coefficients of β_{ijkt}, β_{jkt} and β_{kt} represent he covariates at loan, borrower and branch levels. In all our tests, standard errors are clustered at the borrower level, and are adjusted for heteroscedasticity. Our data allows us to employ a variety of fixed effects to control for the impact of unobservable time varying and time invariant endogenous factors. γX_t represents the fixed effects. We start with branch and year fixed effects in order to control for the impact of time invariant branch level factors and the time trend. We also use month fixed effects to take care of the seasonality in agriculture. In subsequent specifications, we include branch*year and branch*month fixed effects to control for the impact of time varying endogenous factors. By design, the running variable landholdings of the farmers is excluded from the above tests.

At the second stage of our investigations we use the residuals from the above regressions as the dependent variable in our "residualized" RD tests, with the idea that the residuals will capture the impact of the running variable on default net of any confounding effects of the other covariates, and hence the test results will reflect the differential causal impact of the waiver between the two groups of borrowers near the cut off point. The test results are presented in Table 4a below.

Table 4A about here

In the interest of brevity, We report only the second stage results in Table 4a. In column 1, we use residuals obtained with loan level controls such as loan amount and proportion of defaults in total loans in the past 3 years. We also use branch level controls such as rainfall in the region, agricultural production in the region, area under cultivation, agricultural non performing assets in the region and literacy rate, and year fixed effects to control for time trend. In column 2, we use residuals obtained with loan and borrower level controls, and branch and year fixed effects in the first stage. We use branch fixed affects in order to absorb all time invariant branch level factors. The residuals used in column 3 come from a first stage regression that includes branch*year fixed effects to control for time varying branch level factors, in addition to loan and borrower level controls. In

column 4, we maintain the specification of column 3 with one change: we replace year fixed effect with month fixed effects in order to control for the impact of seasonal factors in agricultural production. Finally, in column 5, we include branch*month fixed effects in place of branch*yer fixed effects in the first stage regression.

As can be seen from the first row of Table 4a, our robust RD coefficients indicate that there is no statistically significant difference between the default probability of the full-waiver and partial waiver group farmers who are very close to the cut-off on both sides. Thus, the results reported in Table 3 before remain unaltered even after controlling for the impact of other covariates. The scatter plots from the tests in columns (4) and (6) are presented in Figures 1a and 1b below.

Figure 1a and 1b here

As robustness checks for the above results, we next estimate the residualised RD designs using number of overdue days and total number of days as the dependent variables in different specifications. The results are reported in Tables 4b (overdue days) and 4c (total number of days). All the specifications used exactly mimic Table 4a above.

Tables 4B and 4C about here

The results are completely in line with our earlier results presented in tables 3 and 4a. Figures 2a and 2b below present the scatter plots for specifications which use time varying fixed effects.

Figures 2a and 2b here

All the figures clearly show continuity at the cut-off point.

V.C Concern with RD Design: Diff-in-Diff Specification

A second method we use to control for the impact of other covariates that may vary with the treatment is the conventional diff-in-diff strategy with control variables and various time invariant and time varying fixed effects. Following Hertzberg *et al* (2011), we select borrowers within a narrow band around 2 hectares of landholdings. As we have noted above, farmers very close to the two-hectare landholding cut-off on either side are likely to be similar not only in terms of loan amount, loan outstanding before the waiver, and other critical parameters but also other observable and unobservable characteristics relevant to loan repayment decisions. Full-waiver farmers having landholding just below 2 hectares form our treatment group and partial waiver farmers having landholding just above 2 hectares form our control group.

We estimate the following regression equation;

$$Default_{ijkt} = \beta_0 + \beta_i * branch + \beta_t + \beta_1 * Post + \beta_2 * Fullwaiver + \beta_3 * Fullwaiver * Post + \gamma X_t + \varepsilon_{it}, \quad (2)$$

The dependent variable default is a dummy variable that takes the value of 1 if a farmer i, who borrows from branch k, defaults on a loan j at time t. Otherwise the variables takes the value of 0. The independent variable Post08 is a dummy if the loan j is borrowed in the post waiver period and 0 otherwise. Full-waiver dummy takes the value of 1 if the borrower belongs to the full-waiver group. The independent variable of interest is the interaction between Full-waiver dummy and Post dummy. The interaction term can be represented as follows;

$$\begin{aligned}\beta_1 &= (\overline{Y}_{\text{Treatment Farmers}} - \overline{Y}_{\text{Control Farmers}})\big|_{\text{After Debt Relief}} \\ &\quad - (\overline{Y}_{\text{Treatment Farmers}} - \overline{Y}_{\text{Control Farmers}})\big|_{\text{Before Debt Relief}} \end{aligned} \tag{3}$$

γX_t represents a vector of controls. We are able to control not only for the influence of other covariates but also use data from loans borrowed before waiver. Loan level controls include a measure of credit score for each farmer. This is calculated as the negative of the proportion of defaulted loans in total loans in the pre waiver period. For example, if a farmer (j) borrows 3 loans in the pre waiver period and defaults on one of them, the credit score assigned is -0.33. All time invariant and time varying fixed effects described above are included in different specifications.

Sample selection ensures existence of of parallel trend between control and treatment groups in the pre waiver period Bertrand, Duflo, and Mullainathan (2004). Since both the treatment group and control group farmers are comparable, any shock besides the treatment level coinciding with debt relief is expected to impact them similarly. Debt relief, on the other hand, has a differential impact by design; those just above the 2 hectare cut off are eligible only for partial waiver whereas those just below the cut off are eligible for full waiver.

We report the results of our diff-in-diff test In Table 5 below. The test sample includes full waiver and partial waiver farmers with landholdings between 1.75 and 2.25 hectares. The controls used are similar to the ones used in Table 4a above. The order in which the fixed effects are used also the same as for Table 4a. The coefficients of the interaction term between Full Waiver and Post dummies in all specifications are statistically indistinguishable from zero, indicating that there is no difference between the loan repayment behavior between the two groups in the post-waiver period. They resoundingly confirm our earlier inferences based on RD and residualised RD tests.

Table 5 about here

VI Addressing Concerns Regarding Ex-post Incentive Effects Evidence

In this section we address a couple of possible concerns with the ex-post adverse incentive effects leading to strategic behavior by the borrowers in the post-waiver period.

VI.A Self-selection by borrowers?

If the borrowers in our sample could manipulate the running variable landholdings around the discontinuity threshold of two hectares with a view to self-selection into the group below the threshold, then the variation in the treatment around the threshold would not be random, and our RD test results would be vitiated. However, as we have noted in the introduction, such self selection is extremely unlikely in our setting. First, by its very nature land is not an infinitely divisible asset. More importantly, farmers organize their land into fields of various sizes, making it difficult to cut out a small piece from the field in order to slip into a smaller group. Secondly, the loans that were eventually eligible for the program would have been borrowed, and landholdings pledged as collateral, more than a year before the waiver announcement, given that crop loans in India typically have a maturity period of one year. Correct anticipation of the program and consequent self selection that far back would be inconceivable. In fact, judging by all available evidence based on extensive database search, the program was unanticipated before its announcement. It was the first nation-wide agricultural debt relief program in India after 1990. The years immediately preceding the program experienced normal annual rainfall and increasing food grains production. In particular, the year 2007 was a good year in terms of rainfall as well as agricultural production**?**

Nevertheless, we run McCrary (2008) test to check for evidence of bunching of borrowers in our sample below 2 hectares of landholdings. The results are reported in Figure 3 below.

Figure 3 here

From the figure there does not seem to be any bunching to the left of the threshold. However, we detect bunching to the right of the cut-off. Our tests with 1 and 3 hectares as the cut-off also find similar bunching always to the right of the cut-off, as reported in Figures 4 and 5 below. Kanz (2011) also reports bunching at 1 and 4 hectares. we conclude, as he does, that our tests detect bunching at whole numbers. It has much to do with the nature of land as an asset which is not easily broken up into smaller pieces, and little with self-selection.

Figures 4 and 5 here

VI.B Selection of borrowers by bank loan officers?

Does selection of borrowers by bank loan officers in the post-waiver period contribute to our adverse incentive effects results? It is known that soft information possessed by loan officers, such as borrowers' personality, family reputation and other qualities including honesty and integrity, plays an important role in bank lending Petersen (2004). Selection of borrowers based on soft information can potentially make the post-waiver sample of borrowers unrepresentative of the pre-waiver sample, possibly inserting a higher proportion of bad borrowers who have developed a special relationship with the concerned loan officers. Soft information by definition is hard to control for as it may vary with time at the borrower level. Even borrower fixed effects may not be of much help because they take care of only time invariant factors. There is an additional related issue. It has been noted that loan officers in public sector banks in India have an incentive to evergreen loans (Banerjee and Duflo (2014) in order to postpone booking of defaults with their negative consequences, including investigations for corruption. Since such loans have a higher probability of default, this may create a bias in results in favor of our hypothesis of adverse ex-post effects.

to address this concern, we use our special data on government-mandated exogenous rotation of loan officers to classify the bank branches in our sample into two types: those that experience a loan officer change within a short time following the waiver program and those where the same loan officer continues. Our premise is that the incoming loan officer is less likely to develop borrower-specific soft information within a short time, and hence will take lending decisions based on hard information. Credit history and landholding information are the only such hard information available to the incoming loan officer. Therefore, in cases where there is a change in loan officers, borrower selection is not likely to be an issue, given that we will employ borrower level fixed effects and controls for hard information in our tests. Further, as an additional help, the new loan officer is less likely to evergreen loans given by the previous loan officer. In Table 6 below, we report the results of our robust RD designs to test for evidence of borrower selection influencing our ex-post borrower behavior results.

Table 7 about here

In order to ensure that the new loan officers do not have enough time to develop borrower-specific soft information, we restrict the post-waiver period to December 31, 2008. The Default dummy is the dependent variable in all specifications. Columns 1 and 2 report the results for branches that experience a loan officer rotation during 2008. In column 2, we report the results for residualised robust RD design. Our robust RD estimates in the first row of the table indicate that even in branches where the chances of selection of bad borrowers by the loan officer are remote, a debt waiver fails to improve the default rate of the full waiver beneficiaries. Their default probability is statistically

the same as that of the partial waiver beneficiaries. Though the difference is positive, it is not significant. In columns 3 and 4, we report the corresponding results for branches that do not experience a rotation. Our results remain unchanged in such branches. In column 5, the test results include officer fixed effects and the entire sample. Finally, in column 6, we include borrower fixed effects along with the other controls and the entire sample. Our results of no observable difference between the full waiver and partial waiver beneficiaries remain unchanged in all specifications. We conclude that selection of borrowers by bankers is not a concern in our setting and does not influence our ex post borrower incentives results.

VII Evidence on Ex Ante Selection and Credit Rationing

The existing literature has recognised that political interventions in debt contracts may lead to ex-ante selection and related credit market inefficiencies Bolton and Rosenthal (2002). However, empirically identifying adverse selection is far from straightforward (Karlan and Zinman, 2009). In an attempt to identify evidence of credit rationing, we again use our special data on tenure on bank loan officers indicating government-mandated exogenous rotation. Following the method discussed in the previous section of this paper, we classify the bank branches in our sample into two types. Type 1 branches are those that experience a loan officer change within a short time following the waiver program, while type 2 branches are those where the same loan officer continues. We then conduct two sets of tests.

Our first set of tests use the probability of no loan in the post-waiver period for a pre-waiver borrower as the dependent variable. We design robust RD tests between full waiver and partial waiver beneficiaries around the two-hectare cut-off with land as the running variable separately for the two types of bank branches. We report the first set of results in Table 7 below. In the table, the data is organised at the borrower level. The dependent variable is a dummy that takes the value of 1 if a borrower i does not have a loan in the post-waiver period until December 31st 2008 and zero otherwise. In column 1, we report the results for all branches. In column 2, we include only type 1 branches that undergo a loan officer rotation between the program effective date (February 29, 2008) and December 31st 2008. In column 3, we include only type 2 branches where the loan officers were not rotated in the said period. The robust RD design estimates from the first row of the table indicate that on an average full waiver beneficiaries have a 34.6% higher chance of not having a loan in the post-waiver period than comparable partial waiver beneficiaries in type 1 bank branches. However, in branches where the same loan officers continue, there is no difference in new loan probability of between the two groups

of borrowers.

Table 7 about here

Our second set of tests use the amount of loans in the post-waiver period as the dependent variable. In our RD designs land remains the running variable and two hectares the cut-off. We report the results in table 8 below. In the first column, we consider all loans issued to the full sample of borrowers in the post waiver period until the end of our sample period, December 31, 2012. On an average, the loan amount is significantly lower for full-waiver borrowers than comparable partial-waiver borrowers. The economic magnitude of the difference is about INR 9,300 which is equal to approximately 31% of the median loan size for the full sample of borrowers in the post-waiver period. In the second and third columns, we report estimates for type 1 branches that undergo a loan officer rotation in the post waiver period. In column 3, we include estimates from a residualised RD design. The results in both columns indicate significant difference in the amount of credit received by full waiver and comparable partial waiver farmers around the cut-off . The economic magnitude ranges from INR. 36.3k to INR. 39.8k, or on an average INR 38,000 . This amount is higher than the median loan size for the full sample (INR 30,000) in the post-waiver period. However, there is no difference in the loan amount of the two groups in type 2 branches where the same loan officers continue. As the results before, this last result also holds for both RD designs (column 4) and residualized RD designs (column 5).

Table 8 about here

Combining the results of the two sets of tests, in the post waiver period full waiver beneficiaries have a 34.6% higher chance of not having a loan and approximately INR 38,000 less in loan amount than partial-waiver beneficiaries with comparable landholdings in bank branches with a new loan officer. The evidence raises a number of intriguing questions. First, does the evidence suggest ex ante adverse selection and credit rationing in the case of the full waiver borrowers in those branches? Second, in type 2 branches where there was no rotation, we do not observe any statistically significant difference between the two groups of borrowers either in the probability of new loans or in their size. Why do the full waiver borrowers not face credit rationing in type 2 branches? Third,why do partial waiver borrowers fare better than full waiver borrowers in type 1 branches, while not any worse in the other branches? We address the questions in this order.

First, since we observe only equilibrium outcomes, there is an issue of identification of demand and supply. How do we ascertain that the observed absence of new loans in certain cases and decline in loan size in others is a supply effect, and not a demand effect? There could be a suggestion that loan demand for full waiver and partial waiver borrowers even with similar landholdings is different in the post-waiver period due to the impact of the difference in treatment. Full waiver farmers may have lower demand for

new loans as their entire debt burden is written off, freeing up their capital. However, in that case we would observe lower loan demand for full waiver borrowers in both types of branches, not just the branches that experience loan officer rotation. In other words, we make the reasonable identifying assumption that the difference in demand between full waiver and partial waiver farmers at the margin (near the cut-off of 2 hectares) is unlikely to be correlated with the continuation or rotation of the loan officers who served before the waiver. Therefore, any observed difference in loan amount is supply-driven. The same identification strategy also disposes of some other arguments for low loan demand, such as stigma in borrowing, fixed costs of accessing formal finance, transition to other banks etc. Further, in our sample all borrowers are defaulters who already had access to formal finance. Finally, as we noted in Section II before , agricultural loans in India are available up to a point at a steep discount even to the risk free rate. The discount is as high as 450 basis points. This fact further weakens demand-based explanations.

Second, why do we not observe evidence of rationing in branches where the same loan officers continue? The reported results for type 2 branches potentially reflect two confounding factors which are absent in the case of a new loan officer. One, as we have noted in section II before, loan officers are known to ever-green bad loans regularly in order to avoid booking defaults with their negative consequences, including investigations for corruption (Banerjee and Duflo (2014)). Employed as an alternative to rationing potentially bad loans, such ever-greening may actually increase in the presence of moral hazard induced by the waiver. Two, continuing loan officers are likely to posses soft information about the borrowers and also have access to informal networks(Fisman, Paravisini, and Vig (2012), especially in rural economies. which may help them enforce loan contracts even in the presence of increased moral hazard. By contrast, in branches where a new loan officer takes charge both factors are missing. Neither does the new loan officer possess soft information nor does she have incentives to evergreen loans given by her predecessor. In fact, it has been shown that the incoming loan officer has incentives to expose the outgoing loan officer Hertzberg, Liberti, and Paravisini (2010).

Finally, why should full waiver beneficiaries in a branch with a new loan officer face credit rationing, while the average partial waiver beneficiary in the same branch does not? As we have noted above, a new loan officer has only hard information to go by, including credit history and landholdings. In the present case, credit history for the average borrower in the two groups in our sample is pretty similar, both groups having defaulted on the last loan before the program, while landholdings are also similar by design. For the loan officer, what makes the two groups different is her anticipation how the two groups will behave in the event of a future bailout program. She rationally anticipates that the next bailout will again be more favorable to the smaller group, as bailout programs typically are. In that event, the current full waiver group will become more susceptible to moral hazard and strategic behavior than the other group. Accordingly, she resorts to

ex ante selection to limit the possible damage.

Though indirect, Our evidence on credit rationing is clear and consistent across tests. Let us note that the evidence is also consistent with the evidence on ex post adverse incentive effects in the case of full waiver beneficiaries documented before. We have observed before that there is no evidence of selection of borrowers by loan officers that contributes to the ex post effects. In this section we have gone further. We have presented suggestive evidence that the loan officers actually try to limit ex post negative behavior of full waiver borrowers by resorting to ex ante selection. In other words, the observed negative ex post effects would be stronger in the absence of such selection. The evidence presented in the two parts of this paper adds up nicely to support the central theme of the paper, namely that unconditional government debt relief programs lead to both ex post adverse incentive effects and ex ante adverse selection effects.

VIII Conclusion

In this paper we have investigated the effects of a large-scale debt relief program on the post-waiver debt repayment behavior of borrowers and credit decisions by lenders in a rural credit market. In our setting which captures actual conditions in many emerging economies, the farmers borrow from banks at a subsidized rate and from informal sources at a substantially higher rate, debt contract enforcement is imperfect, and political interventions in the credit market in the form of debt relief can happen even in normal states of the economy. The scope of our investigations has been comprehensive and has included all classes of borrowers: those who receive full debt relief and those who receive partial debt relief. Our empirical tests show that the debt relief does not lead to any improvement in the loan repayment behaviour of the full waiver beneficiaries compared to the partial waiver beneficiaries. Expectations of similar debt relief in future generates moral hazard and strategic loan repayment. Further, rationally anticipating adverse behavior, the lending institutions ration credit in the case of full waiver beneficiaries, generating ex ante inefficiency as well. In sum, our work provides empirical evidence on both hidden information (ex ante selection based on unobserved but anticipated effort) and hidden action (ex post incentive effects) implications of a large government-initiated debt relief program. In the case of an unconditional debt waiver program, both types of evidence are negative.

For our empirical investigations we have used loan accounts data for a large sample of rural borrowers before and after a massive nation-wide debt relief program undertaken by the Indian government in 2008. The ADWDRS program remains one of the largest such programs in history, ultimately covering 36 million farmers and costing about 1.3% of the Indian GDP at the time. However, apart from its direct monetary costs and adverse efficiency implications, the program involved other substantial costs for the economy. It

represented a massive transfer to the agricultural sector at the expense of other activities and services of the government when the government ran a sizable budget deficit even before the program. It is beyond the scope of the present paper to attempt to estimate the cost implications for the other sectors in a general equilibrium framework. However, those costs too must have been substantial. We do not find records suggesting that those other costs, and their implications, were extensively discussed in policy circles. The policy makers who undertake a massive policy initiative of this kind should recognize, and worry about, both direct and indirect costs of the initiative.

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Table 1: Variable Definition

A description of important variables used in the regressions is provided below.

Variable	Description
Waiver_Dummy	Takes the value of 1 if a farmer defaults on last loan prior to Feb, 29th 2008 and 0 otherwise
Fullwaiver_Dummy	Takes the value of 1 if a farmer with a landholding of not more than 2 hectares qualifies for the waiver and 0 otherwise
Partialwaiver_Dummy	Takes the value of 1 if a farmer with a landholding of more than 2 hectares qualifies for the waiver and 0 otherwise
Post08_Dummy	Takes the value of 1 for loans granted after Feb 29th, 2008 and 0 otherwise
Default_Dummy	Takes the value of 1 for loans outstanding (not overdue) beyond 365 days.
Days	Total Number of days a loan is outstanding
Overdue	Number of days a loan is outstanding over and above 365 days
Score	Proportion of defaulted loans to total loans in the pre waiver period multiplied by minus 1
Loan	Loan amount in Indian Rupees
District	Equivalent of a County in the United States
Loan Officer	A branch manager who has ultimate loan sanctioning authority
Rationed_Dummy	Takes the value of 1 if a borrower does not have a loan in the post waiver period and 0 otherwise

Table 2A: Summary Statistics

The table reports key summary statistics at the borrower-loan level. In the first row, we report numbers pertaining to all borrowers in the data. In the second row, we restrict the sample to borrowers whose loan as well as landholding information is available. Third and fourth row, report the numbers separately for borrowers who received 100% waiver and those that received only 25%. In the first column, we report the number of Farmers in the sample. In the second column, we report the number of loans availed by such farmers. In columns 3 and 4, we separate the loans into pre-waiver and post-waiver loans. The data is from loan account level information obtained from a public sector bank. The data covers the period from 2005-2006 to 2010-2011

Particulars	No.of borrowers	No. of loans	Pre Waiver	Post-waiver
Accounts with loan information	12105	35049	15396	19653
Accounts with information on loan as well as land	6662	19408	8090	11318
Accounts with less than or equal to 2 hectares of land	4556	13438	5489	7949
Accounts with more than 2 hectares of land	2106	5970	2601	3369

Table 2B: Summary Statistics

The table reports key summary statistics of the loan accounts. We report details pertaining to land pledged, Loan Amount and Outstanding Loan Amount. We classify the data into pre and post waiver. Further, we sub-classify the data into that of full waiver and partial waiver beneficiaries. We report mean, median and standard deviation for all variables. The data is from loan account level information obtained from a public sector bank. The data covers the period from 2005-2006 to 2010-2011.

Average loan characteristics before and after waiver			
	Mean	Median	Standard Deviation
Land Pledged Data for the entire sample	1.32	2.44	18.66
Land Pledged Data for Full Waiver Beneficiaries	1	1	0.52
Land Pledged Data for Partial Waiver Beneficiaries	5.65	3.09	33.4
Loan Amount in the pre waiver period -full sample	34351	25000	44964
Loan amount in the post waiver period -full sample	42077	30000	42882
Loan Amount in the pre waiver period for full waiver beneficiaries	25133	18000	30142
Loan Amount in the post waiver period for full waiver beneficiaries	32520	25000	31120
Loan Amount in the pre waiver period for partial waiver beneficiaries	53803	44000	61758
Loan Amount in the post waiver period for partial beneficiaries	66624	51471	56297
Loan amount Outstanding before waiver for full waiver beneficiaries	22710	20277	29309
Loan amount Outstanding before waiver for Partial waiver beneficiaries	43451	42744	37915

Table 3: Effect of Debt Waiver on loan repayment- Robust, Bias Corrected and Conventional RD estimates

This table reports the regression discontinuity (RD) results for the impact of debt relief on future loan repayment behaviour of the beneficiaries. Land is the running variable with a cut-off 2 hectares (as specified by the ADWDRS in 2008) where RD specification estimates the significance of $E[Y_i(1) - Y_i(0)|X_i = \bar{x}]$. We use procedure developed by Calonico, Cattaneo, and Titiunik (2014) to estimate robust and bias corrected standard errors. Each line of data represents a loan. In the first column, the dependent variable is the default dummy. In the second column, we use number overdue days as the dependent variable and in the third column, we use total number of days a loan is outstanding as the dependent variable. In the first row, we report results after estimating robust standard errors. We also report bias-corrected as well conventional RD coefficients in the second and the third row. We restrict the sample to post waiver loans. Standard errors are reported in parentheses. ***, **, * represents statistical significance at the 1%, 5% and 10% levels.

VARIABLES	Default	Overdue	Days
Robust	-0.003	-36.669	12.004
	[-0.043]	[-1.065]	[0.278]
Bias-corrected	-0.003	-36.669	12.004
	[-0.114]	[-1.436]	[0.407]
Conventional	0.133***	-1.616	55.790*
	[4.721]	[-0.063]	[1.890]
Observations	6,326	4,198	4,527

Table 4A: Effect of Debt Waiver on loan repayment- Robust RD using residuals

These tables report the regression discontinuity (RD) results for the impact of debt relief on loan repayment behaviour after obtaining residuals from a first stage regression of default on covariates other than land. Land holding pledged by a farmer is the running variable with cut-off of 2 hectares (as specified by the ADWDRS in 2008). The RD specification estimates the significance of $E[Y_i(1) - Y_i(0)|X_i = \bar{x}]$. We use procedure developed by Calonico, Cattaneo, and Titiunik (2014) to estimate robust and bias corrected standard errors. It is to be noted that the dependent variable, which is default in this case, corresponds to the residuals obtained from the regressions where the independent variables include borrower level, loan level and branch level characteristics. In Column 1, we employ year fixed effects. In column 2, we employ branch and year fixed effects. In column 3, we use branch X year fixed effects. In column 4, we estimate the residuals after using branch and month fixed effects. In column 5, we employ branch X month fixed effect to estimate residuals. Standard errors are reported in parentheses. ***, **, * represents statistical significance at the 1%, 5% and 10% levels.

VARIABLES	Default_Res	Default_Res	Default_Res	Default_Res	Default_Res
Robust	0.018	0.002	0.004	0.020	-0.000
	[0.359]	[0.056]	[0.105]	[0.367]	[-0.003]
Bias-corrected	0.018	0.002	0.004	0.020	-0.000
	[0.439]	[0.087]	[0.144]	[0.632]	[-0.006]
Conventional	0.055	0.005	0.006	0.028	0.031
	[1.349]	[0.192]	[0.196]	[0.858]	[0.898]
Observations	2,749	5,056	4,090	4,007	3,562

Table 4 (B): Effect on Debt Waiver on Loan Repayment- Alternative Measures

These tables report the regression discontinuity (RD) results for the impact of debt relief on loan repayment behaviour. Land holding pledged by a farmer is the running variable with cut-off of 2 hectares (as specified by the ADWDRS in 2008). The RD specification estimates the significance of $E[Y_i(1) - Y_i(0)|X_i = \bar{x}]$. We use procedure developed by Calonico, Cattaneo, and Titiunik (2014) to estimate robust and bias corrected standard errors. It is to be noted that the dependent variable, which is number overdue days in this case, corresponds to the residuals obtained from the regressions where the independent variables include borrower level, loan level and district level characteristics. In Column 1, we employ year fixed effects. In column 2, we employ branch and year fixed effects. In column 3, we use branch X year fixed effects. In column 4, we estimate the results after using branch and month fixed effects. In column 5, we employ branch X month fixed effect. Standard errors are reported in parentheses. ***, **, * represents statistical significance at the 1%, 5% and 10% levels.

VARIABLES	Overdue_Res	Overdue_Res	Overdue_Res	Overdue_Res	Overdue_Res
Robust	20.628	29.046	8.367	23.682	23.726
	[0.739]	[1.003]	[0.390]	[0.749]	[0.754]
Bias-corrected	20.628	29.046	8.367	23.682	23.726
	[0.967]	[1.377]	[0.520]	[1.018]	[1.029]
Conventional	21.877	30.443	9.352	44.860*	48.739**
	[1.026]	[1.443]	[0.581]	[1.928]	[2.115]
Observations	3,475	3,512	5,114	3,366	3,362

Table 4 (C): Effect on Debt Waiver on Loan Repayment- Alternative Measures

These tables report the regression discontinuity (RD) results for the impact of debt relief on loan repayment behaviour. Land holding pledged by a farmer is the running variable with cut-off of 2 hectares (as specified by the ADWDRS in 2008). The RD specification estimates the significance of $E[Y_i(1) - Y_i(0)|X_i = \bar{x}]$. We use procedure developed by Calonico, Cattaneo, and Titiunik (2014) to estimate robust and bias corrected standard errors. It is to be noted that the dependent variable, which is number days a loan is outstanding in this case, corresponds to the residuals obtained from the regressions where the independent variables include borrower level, loan level and district level characteristics. In Column 1, we employ year fixed effects. In column 2, we employ branch and year fixed effects. In column 3, we use branch X year fixed effects. In column 4, we estimate the results after using branch and month fixed effects. In column 5, we employ branch X month fixed effect. Standard errors are reported in parentheses. ***, **, * represents statistical significance at the 1%, 5% and 10% levels.

VARIABLES	Days_Res	Days_Res	Days_Res	Days_Res	Days_Res
Robust	37.391	23.174	18.939	13.231	44.810
	[0.976]	[0.532]	[0.590]	[0.284]	[1.127]
Bias-corrected	37.391	23.174	18.939	13.231	44.810
	[1.346]	[0.930]	[0.991]	[0.476]	[1.563]
Conventional	47.595*	45.840*	19.648	69.744**	77.309***
	[1.713]	[1.840]	[1.028]	[2.511]	[2.696]
Observations	3,437	3,892	5,647	3,437	3,101

Table 5: Effect of Debt Waiver on loan repayment- Difference-In-Difference

This table reports the difference-in-difference results for the impact of debt relief on loan repayment behaviour. The sample is restricted to farmers having a landholding of 1.75 to 2.25 hectares. Full-waiver group consists of farmers having landholding between 1.75 and 2 hectares whereas partial waiver group consists of farmers having landholding of more than 2 hectares. Default dummy is the dependent variable. Post08 refers to period after the waiver announcement. The main independent variable of interest is the interaction between fullwaiver and post08 dummies. This represents our dif-n-dif measure. In column 1, we include borrower level, loan level and district level controls in addition to year fixed effects. Columns 2 to 5, contain fixed effects of similar nature and in the same order as in Table 4. Standard errors are clustered at the borrower level. Standard errors are reported in parentheses. ***, **, * represents statistical significance at the 1%, 5% and 10% levels.

VARIABLES	Default	Default	Default	Default	Default
Post08	0.538***	0.518***	0.536***	-0.134***	-0.128***
	[7.454]	[7.534]	[7.933]	[-4.432]	[-4.141]
Fullwaiver	0.023	0.029	0.050*	-0.004	-0.002
	[0.895]	[1.101]	[1.833]	[-0.142]	[-0.079]
Full X Post	-0.019	-0.009	-0.055	0.041	0.033
	[-0.456]	[-0.226]	[-1.288]	[1.053]	[0.819]
Loan	0.000	0.000**	0.000**	0.000	0.000
	[1.435]	[2.506]	[2.096]	[0.794]	[0.724]
Score	-0.834***	-0.849***	-0.841***	-0.845***	-0.843***
	[-19.844]	[-18.997]	[-19.560]	[-19.664]	[-19.078]
Agri_Credit	Yes				
Area Under Rice	Yes				
Agri_Npa	Yes				
Literacy	Yes				
Rainfall	Yes				
Inflation	Yes				
Yield	Yes				
Branch FE	No	Yes	No	Yes	No
Year FE	Yes	Yes	No	No	No
Branch X Year FE	No	No	Yes	No	No
Month FE	No	No	No	Yes	No
Branch X Month FE	No	No	No	No	Yes
Observations	2,221	2,221	2,221	2,221	2,221
R-squared	0.300	0.321	0.360	0.235	0.270

Table 6: Impact of waiver on branches with same loan officer continuing after waiver when compared to other branches.

This table report the regression discontinuity (RD) results for the impact of debt relief on loan repayment behaviour. In order to address selection concerns, we compare the impact between branches with same and different loan officer in the post waiver period when compared to pre waiver period. Land holding pledged by a farmer is the running variable with cut-off of 2 hectares (as specified by the ADWDRS in 2008). The RD specification estimates the significance of $E[Y_i(1) - Y_i(0)|X_i = \bar{x}]$. We use procedure developed by to estimate robust and bias corrected standard errors. It is to be noted that the dependent variable, which is default dummy, corresponds to the residuals obtained from the regressions where the independent variables include borrower level, loan level and district level characteristics. In columns 1 and 2, we cover branches that see a change in loan officer in the post waiver period when compared to pre waiver period. In columns 3 and 4, we cover other branches. Columns 1 and 3, report the results without residualising whereas columns 2 and 4, report the results using residuals of default. In Column 5 and 6, we run the discontinuity on the entire sample using officer and borrower fixed effects respectively. We restrict the post waiver period to calender year 2008 to ensure that the new loan officer do not have much soft information. Standard errors are reported in parentheses. ***, **, * represents statistical significance at the 1%, 5% and 10% levels.

VARIABLES	default	default_res	default	default_res	default_res	default_res
Robust	1.293	0.426	0.043	0.020	0.016	0.036
	[0.668]	[0.436]	[0.522]	[0.262]	[0.374]	[1.115]
Bias-corrected	1.293	0.426***	0.043	0.020	0.016	0.036
	[1.190]	[3.521]	[0.654]	[0.355]	[0.597]	[1.447]
Conventional	0.803	0.114	0.036	0.014	0.014	0.027
	[0.740]	[0.946]	[0.548]	[0.243]	[0.513]	[1.079]
Observations	315	510	1,020	1,525	5,034	4,527

Table 7: Loan After Waiver- Same Loan Officer and Different Loan officer Branches.

This table reports the regression discontinuity (RD) results for the impact of debt relief on chances of having a new loan in the post waiver period. In order to address selection concerns, we compare the impact between branches with same and different loan officer in the post waiver period when compared to pre waiver period. Land holding pledged by a farmer is the running variable with cut-off of 2 hectares (as specified by the ADWDRS in 2008). The RD specification estimates the significance of $E[Y_i(1) - Y_i(0)|X_i = \bar{x}]$. We use procedure developed by Calonico, Cattaneo, and Titiunik (2014) to estimate robust and bias corrected standard errors. Our dependent variable, Noloan, takes the value of 1, if a borrower does not have a loan in the post waiver period. In column 1, we report the results for the entire sample. In column 2, we restrict our sample only to those branches which witness a change in loan officer during 2008, immediately after waiver. In column 3, we consider branches that continue to have same loan officers even after waiver. Standard errors are reported in parentheses. ***, **, * represents statistical significance at the 1%, 5% and 10% levels.

VARIABLES	Noloan	Noloan	Noloan
	All	Diff-officer	Same-officer height
Robust	-0.057	-0.346**	0.012
	[-1.246]	[-2.086]	[0.183]
Bias-corrected	-0.057	-0.346***	0.012
	[-1.567]	[-4.687]	[0.218]
Conventional	-0.048	-0.108	-0.004
	[-1.333]	[-1.462]	[-0.066]
Observations	3,495	1,404	1,473

Table 8: Loan Amount After Waiver- Same Loan Officer and Different Loan officer Branches

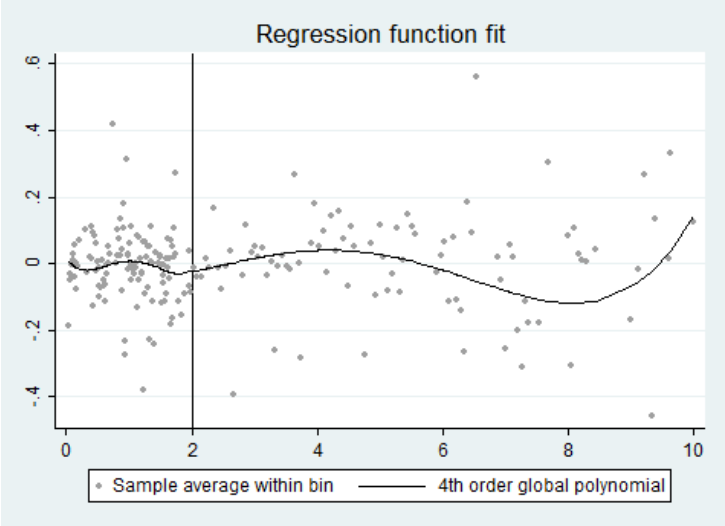
This table reports the regression discontinuity (RD) results for the impact of debt relief on amount of new loan in the post waiver period. In order to address selection concerns, we compare the impact between branches with same and different loan officer in the post waiver period when compared to pre waiver period. Land holding pledged by a farmer is the running variable with cut-off of 2 hectares (as specified by the ADWDRS in 2008). The RD specification estimates the significance of $E[Y_i(1) - Y_i(0)|X_i = \bar{x}]$. We use procedure developed by Calonico, Cattaneo, and Titiunik (2014) to estimate robust and bias corrected standard errors. Our dependent variable, Loan, denotes the amount of loan. In column 1, we report the results for the entire sample. In column 2 and 3, we restrict our sample only to those branches which witness a change in loan officer during 2008, immediately after waiver. In column 4 and 5, we consider branches that continue to have same loan officers even after waiver. In columns 3 and 5, we use residuals to estimate the RD equation. Standard errors are reported in parentheses. ***, **, * represents statistical significance at the 1%, 5% and 10% levels. Standard errors are reported in parentheses. ***, **, * represents statistical significance at the 1%, 5% and 10% levels.

VARIABLES	Loan	Loan	Loan	Loan	Loan
	All	Diff-officer	Diff-officer	Same-off	Same-off
Robust	9,311.300***	39,840.431*	36,271.107*	4,162.836	9,196.756
	[3.237]	[1.778]	[1.873]	[0.870]	[1.381]
Bias-corrected	9,311.300***	39,840.431***	36,271.107***	4,162.836	9,196.756***
	[3.194]	[3.403]	[8.967]	[1.124]	[3.424]
Conventional	-1,268.006	17,359.861	248.927	3,797.899	415.118
	[-0.435]	[1.483]	[0.062]	[1.025]	[0.155]
Observations	1,334	361	530	814	2,937

Figure 1: Regression discontinuity (RD) plots for farmers having land-holding near the threshhold of 2 hectares based on Table 4.

The figures below depict the RD plots using the default technique of "Mimicking variance evenly spaced using spacings estimators". "Evenly spaced" here implies evenly spaced bins for the construction of the partitioning scheme underlying the RD plots. "Mimicking variance" selects the number of bins in a way which generates local sample means with an asymptotic variability mimicking the overall variability of the data. For further details on the methodology and spacings estimators, please refer to (**?**). Here we depict plots for residualised regression given in Table 4. Default dummy is the dependent variable.

(a) Residuals after including Branch X Year Fixed Effects



(b) Residuals after including Branch X Month Fixed Effects

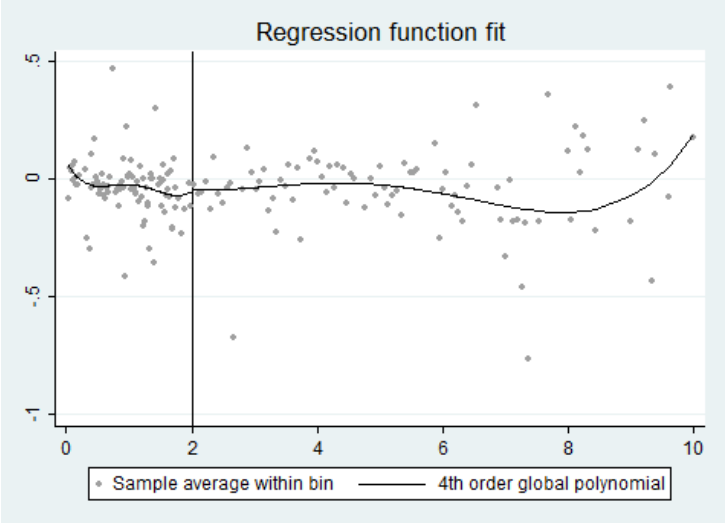
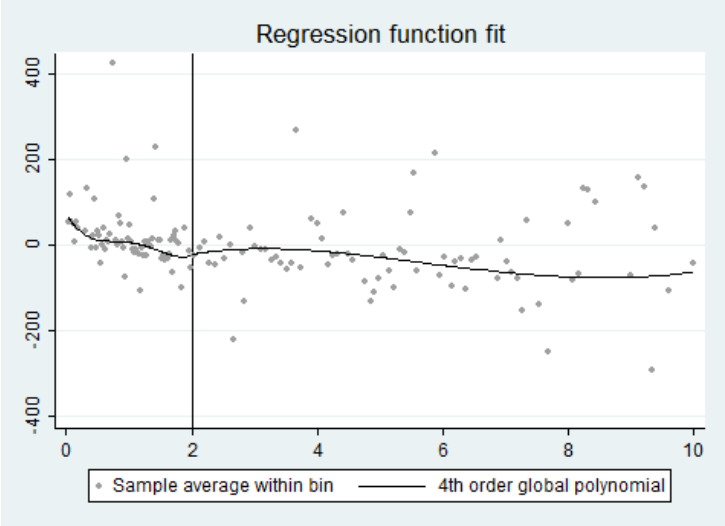


Figure 1: Regression discontinuity (RD) plots for farmers having land-holding near the threshhold of 2 hectares based on table 6.

The figures below depict the RD plots using the default technique of "Mimicking variance evenly spaced using spacings estimators". "Evenly spaced" here implies evenly spaced bins for the construction of the partitioning scheme underlying the RD plots. "Mimicking variance" selects the number of bins in a way which generates local sample means with an asymptotic variability mimicking the overall variability of the data. For further details on the methodology and spacings estimators, please refer to (**?**). Here we depict plots for residualised regression given in Tables 6A and 6B. In table 6A dependent variable is the number of days overdue. In Table 6B, total days outstanding is the dependent variable

(a) Residuals Overdue after including Branch X Year Fixed Effects



(b) Residuals Days including Branch X Month Fixed Effects

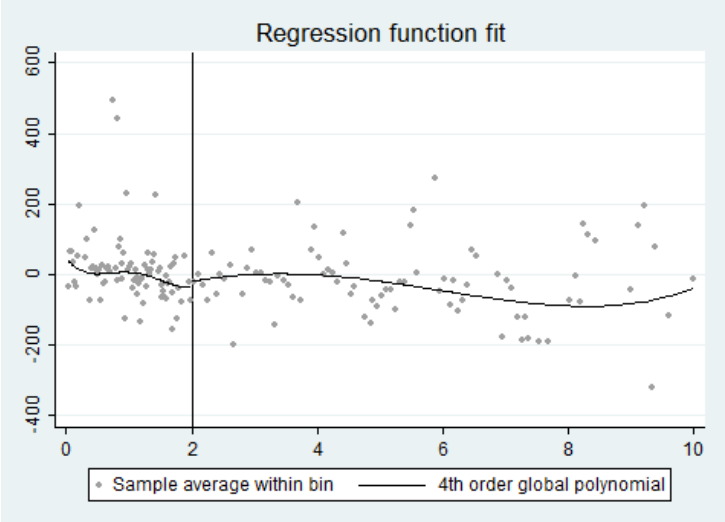


Figure 1: Appendix

Figure 1: McCrary test for discontinuity at cutoff point

The figure below depicts the McCrary test results for the borrowers in our sample. We use the default values of bandwidth and bin size for our estimation. Land is the running variable here with a cut-off of 2 hectares. We report the coefficient and standard error estimates below. However, owing to the non-parametric nature of the test, we do not report a t-statistic.

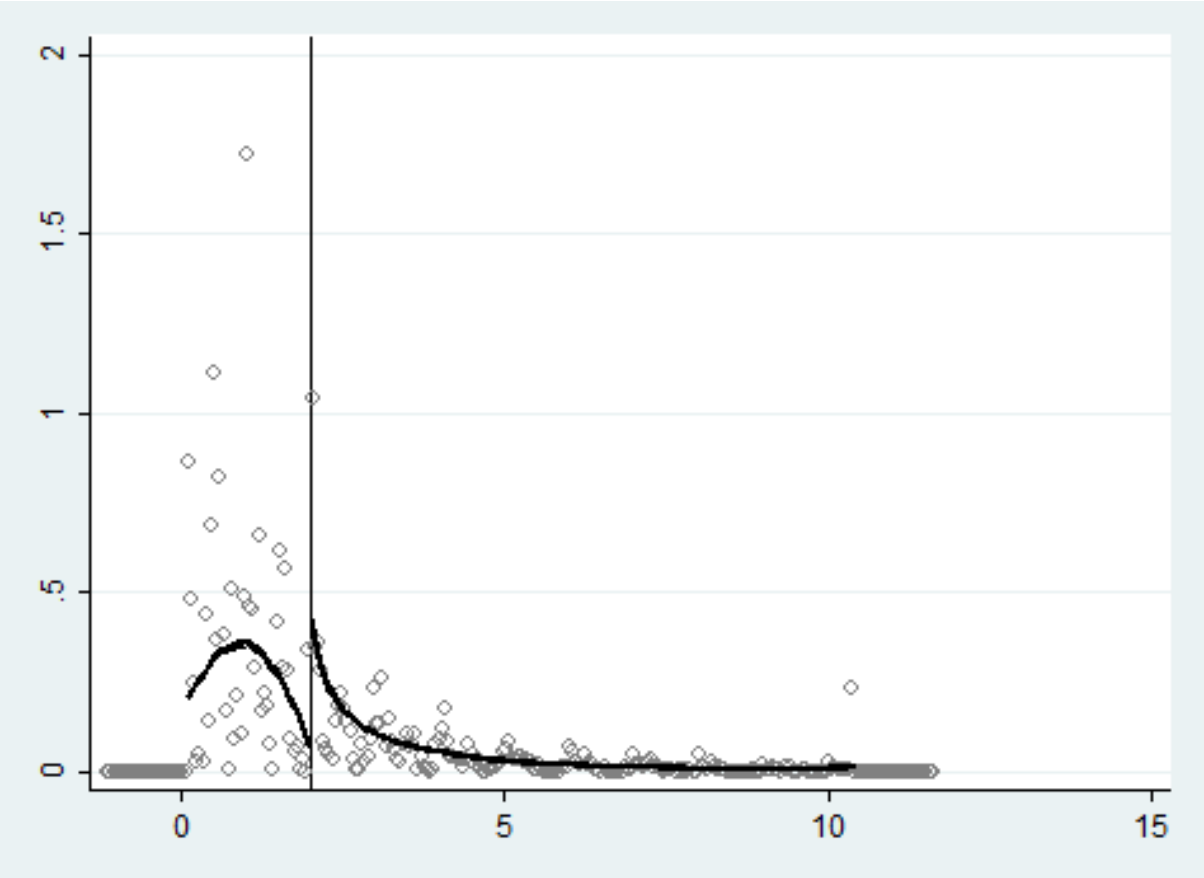


Figure 1: Discontinuity estimate at 2 hectares

Summary Statistics	
Log diff in height at 2 hectares	1.57
Std. Error	0.07
Default Bandwidth	1.04
Default Bin Size	0.02

Figure 2: Appendix

Figure 2: McCrary test for discontinuity at false cutoff point of 1 hectares

The figure below depicts the McCrary test results for the borrowers in our sample. We use the default values of bandwidth and bin size for our estimation. Land is the running variable here with a false cut-off of 1 hectares. We report the coefficient and standard error estimates below. However, owing to the non-parametric nature of the test, we do not report a t-statistic.

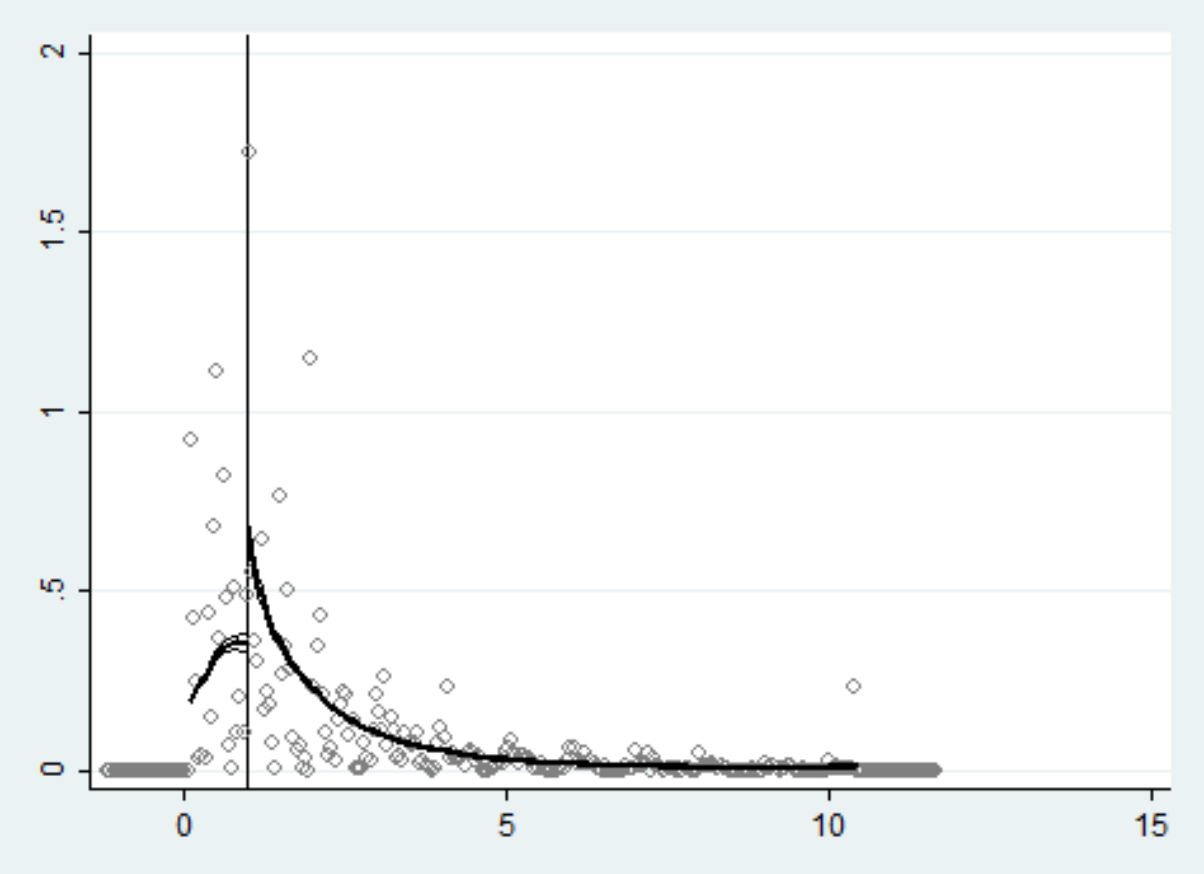


Figure 2: Discontinuity estimate at 2 hectares

Summary Statistics	
Log diff in height at 2 hectares	1.57
Std. Error	0.07
Default Bandwidth	1.04
Default Bin Size	0.02

Figure 3: Appendix

Figure 3: McCrary test for discontinuity at false cutoff point of 3 hectares

The figure below depicts the McCrary test results for the borrowers in our sample. We use the default values of bandwidth and bin size for our estimation. Land is the running variable here with a false cut-off of 3 hectares. We report the coefficient and standard error estimates below. However, owing to the non-parametric nature of the test, we do not report a t-statistic.

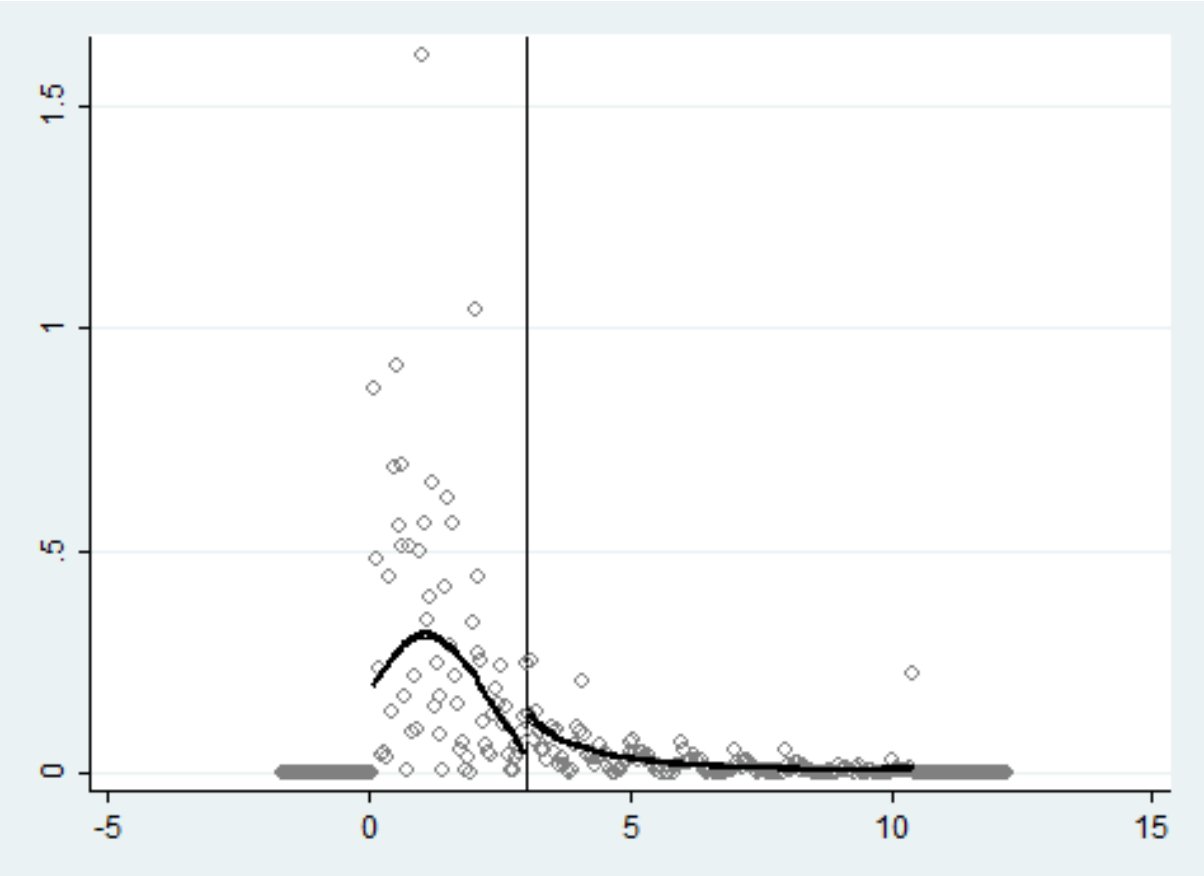


Figure 3: Discontinuity estimate at 2 hectares

Summary Statistics	
Log diff in height at 2 hectares	1.57
Std. Error	0.07
Default Bandwidth	1.04
Default Bin Size	0.02