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Forgive or buy back: an experimental study of debt relief

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Abstract In recent years, debt relief has once again been pushed to the forefront of political and economic interest. The general consensus is that with less debt burden poor countries suffering from debt overhang will be able devote more resources towards investment thereby promoting their own growth and thus benefit their creditors in the long run. An open question is which mechanism is best to relieve debt burden. In this paper, we adopt experimental methods to study the effectiveness and efficiency of debt forgiveness and debt buyback. We find that creditors tend to reduce more debt under Forgiveness than Buyback. Debtors under Forgiveness are not significantly more reciprocal than under Buyback. After controlling for the amount of debt relief, creditors are significantly worse off under Forgiveness whereas debtors are indifferent between the two schemes. From the viewpoint of promoting debt relief, debt forgiveness appears to be a more effective tool to achieve this goal. Nevertheless, if one is to maximize the overall efficiency, debt buyback is superior to debt forgiveness in making best of each relief dollar.

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1 Introduction

The Jubilee Debt Campaign and high-profiled advocates such as the late Pope John Paul II, the Dalai Lama, and most notably U2 lead singer Bono have brought the international spotlight to debt relief over recent years. They, together with hundreds of thousands of anti-poverty campaigners, have helped transform developing countries' external debt issues into a moral movement: demanding an end to "the scandal that poor countries are forced to choose between basic health and education and repaying historical debt."[1] As a response to their pleads, G8 leaders at the 2005 Summit in Gleneagles agreed to cancel 100% of debt obligations, approximately $ 40 billion, owed by some of the poorest countries in the world.

As millions people die of hunger, AIDS, and other poverty-related diseases each year in the world's poorest countries, there is certainly no doubt that their appeal for aid is more urgent than ever. Nevertheless, it is not yet clear if debt relief is really a win-win strategy that would benefit not only debtors, but also their creditors. It has been argued by Krugman (1988), Sachs (1989) and many others that a debt overhang—defined as the expected present value of a country's future resource transfers being less than its debt—must be present in order for both creditors and debtors to benefit from debt relief. Debt overhang makes a debtor country less likely to attract new creditors and thus forces it to forgo profitable investment projects that otherwise would have been undertaken if the overhang were absent. The expected value of repayments decreases as debt overhang impedes growth and increases the probability of default in the long run. The debt overhang hypothesis can be best illustrated using the concept of a debt Laffer curve (Krugman 1989). Figure 1 describes the relationship between the nominal value of a country's debt and the expected value of repayment. A country's debt is more likely to be repaid when it is relatively low. Hence, the debt Laffer curve is upward sloping when the debt is at reasonable low levels. As the debt increases, the risk of default also rises, which decreases the expected value of repayment. Debt overhang eventually takes place when the nominal value of the debt exceeds a critical threshold D*. The debt Laffer curve becomes downward sloping accordingly. In sum, the existence of debt overhang provides an incentive for creditors, at least theoretically speaking, to act collectively and write off some of their debt claims in order to increase the expected value of the debt repayment.

To mitigate the problem of debt overhang, various debt relief schemes have been proposed. Some advocates prefer debt forgiveness, a once-and-for-all reduction in the future obligations of a debtor country, and others prefer more market-based approach such as debt buybacks which allows a debtor to buy back its own debt on a secondary

[1] Refer to http://www.jubileedebtcampaign.org.uk/ for more details regarding the Jubilee Debt Campaign.

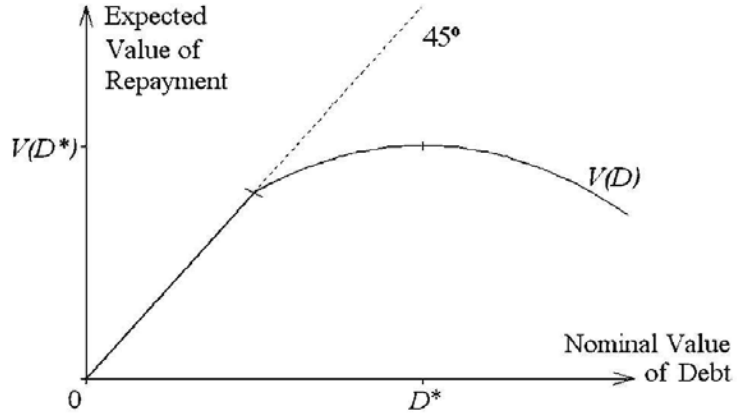

Fig. 1 Debt Laffer curve

market usually at a substantial discount.[2] Krugman (1989) argues that, as long as the debtor country is on the downward sloping side of the debt Laffer curve, debt forgiveness and debt buybacks generate the same theoretical predictions. Therefore, the debtor and its creditors are indifferent, in expected terms, between the two debt reducing schemes.

The concept of debt overhang hypothesis is perhaps straightforward in theory, but its empirical evidence is unfortunately not so obvious. Depending on debt overhang measures, model specifications, sample countries, and sample periods, some papers find an inverse relationship between external debt and investment/economic growth (Savvides 1992; Afxentiou 1993; Cunningham 1993; Rockerbie 1994; Deshpande 1997), whereas others do not (Warner 1992; Cohen 1993; Chowdhury 1994).[3] And worse, even after many different relief schemes have been implemented over the years, systematic investigations on their respective effects are still missing in the empirical literature.

In this paper, we contribute to the literature by providing direct comparisons on the impact of different relieve schemes on debtors' willingness to invest as well as on debtors' and creditors' eventual well-being. We adopt experimental methodologies, and as the first attempt to fill the missing piece in the literature, we compare two simple ways to relief debt: debt forgiveness and debt buyback. While we are mindful of the oversimplification imposed by the laboratory setting, we argue that it also has advantages in this context. First, it allows us to construct an underlying decision environment in which debt relief is necessary to increase the expected debt repayment as well as enhance debtor countries' well-being. This is certainly different from the ambiguities one would encounter when conducting an empirical study in which directly verifying the existence of debt overhang is not possible. The second advantage is the ability to observe relevant variables of interest in a controlled environment, and make truly exogenous ceteris paribus changes. This provides us much greater clarity when

[2] See, for example, Helpman (1989), Dooley (1988), Froot et al. (1989), and Krugman (1989) for other market-based schemes such as buyouts, exit bonds, and debt-equity swaps.

[3] See Karagol (2002) for a summary of empirical studies on the relationship between debt burden and economic slowdown.

comparing the effectiveness of two relief schemes without worrying about their respective impact being compounded with different nuisances. Lastly, this approach allows for precise replicability to ensure for future verification of results and implementation as a baseline for future extensions.

The specific research questions are as follows: (1) Are debt forgiveness and buyback equally effective in inducing debtors' investment effort in order to pay off outstanding debts? (2) Are creditors and debtors indifferent between the two relief schemes? That is, do debt forgiveness and debt buyback generate the same expected payoffs for creditors and debtors respectively? To address these research questions, we construct a simple two-player, two-stage game in which the creditor country is required to make its relief decision before observing investment effort provided by the debtor.[4,5] In the first stage, the creditor country has the option to reduce her debtor country's outstanding debt via one of the two relief schemes depending on the treatment. In the Buyback treatment, the creditor sets a price at which the debtor must pay for each unit of the debt she buys back, usually at a fraction of its full value, and thus reduces the total amount of debt owed. In the Forgive treatment, the creditor has the option to directly cancel the debtor's responsibility of paying back a portion or all of her debt. The second stage of the game is the same across both treatments. The debtor is made aware of the remaining debt outstanding given the decisions of creditors in stage one. Given this information, the debtor must decide a level of real expenditure to invest into a risky project.[6] The higher is the level of investment into the project, the higher is the probability of receiving its payout. If the project succeeds, the debtor receives the project payout, which is sufficient to pay off all outstanding debt to the creditor and possibly retain some surplus itself depending upon the amount of debt relieved in stage 1.

Based on our theoretical model, the experiment is designed so that the relief schemes are not expected to generate different outcomes in terms of (1) the amount of debt relieved by the creditor, (2) the debtor's willingness to invest in order to increase the likelihood to repay the debt, and (3) the expected payoffs of the creditor and the debtor. As a result, we propose the following hypothesis for evaluations:

Hypothesis: The Forgive treatment generates outcomes that are not different from those of the Buyback treatment.

As we report in detail in Sect. 4, our data do not support this hypothesis. Creditors in the Forgive treatment tend to reduce significantly more debt than those in the Buyback treatment. Debtors, on the other hand, do not exert significantly greater investment effort in the Forgive treatment than in the Buyback treatment. Therefore, if one's goal is to promote debt relief from creditors, debt forgiveness is perhaps a more

[4] We choose to study a two-player game in order to avoid possible complications such as free-rider and coordination problems in the presence of multiple creditors.

[5] Note that when a country is suffering from debt overhang, most, if not all, of the returns to its investment will have to be used to service its debt. As a result, a debtor country would have little incentive to undertake any investment or adjustment policies unless some debt has been written off first. For this reason, we decided to make the creditor country the first mover in our game.

[6] One can think of the risky project as some sort of economic or political reform that is self-imposed by the debtor country.

effective tool to attain such a goal. But if one's goal is instead to induce investment effort from debtors, the two relief schemes appear to work equally well, although it will cost creditors more in Forgive than in Buyback to achieve the same outcome. Indeed, if we control for the amount of debt relief, creditors in the Forgive treatment are significantly worse off whereas debtors are indifferent between the two schemes. Hence, from the viewpoint of overall efficiency, debt buyback is definitely superior to debt forgiveness in terms of making best use of the relief money.

One possible explanation for the results described above is that debtors appear to have dramatically different attitude toward stingy creditors in the two relief schemes. We find that when debt relief is less than the optimum, debtors in the Forgive treatment tend to choose an average effort level that is significantly lower than that in the Buyback treatment. So it is not surprising that, to achieve higher payoffs, creditors in the Forgive treatment must relieve more debt than those in the Buyback treatment. Note that having negative responses toward ungenerous or unfair treatments is certainly not a new finding in the experimental literature. What is significant here is that, when relief is not sufficiently high, one relief scheme (debt forgiveness) is more likely to trigger negative reciprocity than the other (debt buyback). Perhaps it is because "forgiveness" itself carries too much normative overtones, as argued by O'Connell (2000), that "not forgiving enough" sets off stronger resentment toward creditors themselves. As a practical matter, it is worth noting that even though debt relief issues in the naturally occurring world are far more complex than those in our laboratory environment, they certainly have become moral matters, thanks to various debt-relief campaigns during the past decade. As such, our results would offer insights that suggest some relief schemes which might alleviate ill feelings against "immoral" creditors.

The rest of the paper is organized as follows. A simple theoretical model is presented in Sect. 2. Section 3 describes the experimental design and procedures. The results are reported in Sect. 4. Section 5 concludes the paper.

2 The model

A simple model of debt overhang that incorporates a specific function of effort costs into a more general model of Krugman (1989) is constructed in the following. Consider a risk neutral debtor country that has inherited a debt whose nominal value D is larger than the country's initial reserves R available for the debt re-payment. A debtor country can potentially pay off its remaining debt $D - R$ by undertaking a costly and risky investment project which, if succeeds, would generate extra income A, where $A \geq D - R$. For simplicity, let us assume that with probability p the project will succeed and thus the debtor country is able to pay off its remaining debt, whereas with probability $1 - p$ the project will fail and thus no extra income will be realized. Let us also assume that the debtor can influence p in the sense that the larger the effort cost that he incurs, the higher the likelihood that the investment will succeed. Specifically, the debtor's disutility of effort, denoted by e, is a convex function of the probability p that the good outcome would occur:

$$e = Ap^{\alpha}, \tag{1}$$

where $\alpha > 1$.

Given p, we can solve for the expected value of the debt re-payments or the creditor's expected payoff V_C. The debtor will only be able to fully repay the debt D in the good state, thus

$$V_C = (1 - p)R + pD. \tag{2}$$

The debtor's expected payoff V_D equals the expected total resources $(R + pA)$ minus the expected debt repayments to her creditor V_C minus its cost for striving for additional resources $e(p)$:

$$V_D = p(A + R - D) - e(p). \tag{3}$$

Finally, let d denote the fraction of A that the debtor country must use to pay off its remaining debt $D - R$. That is,

$$d \equiv \frac{D - R}{A}. \tag{4}$$

After substituting Eqs. (1) and (4) into Eq. (3), the debtor's expected payoff becomes

$$V_D = A[p(1 - d) - p^{\alpha}]. \tag{5}$$

Given d, the debtor country's best response is to exert enough effort so that the probability that the good state would occur is

$$p^*(d) = \left(\frac{1 - d}{\alpha}\right)^{\frac{1}{\alpha - 1}}. \tag{6}$$

Substituting this debtor's best response function into Eqs. (2) and (5) yields the creditors and debtors expected payoffs as

$$V_C^*(d) = R + Ad\left(\frac{1 - d}{\alpha}\right)^{\frac{1}{\alpha - 1}}, \tag{7a}$$

and

$$V_D^*(d) = A(\alpha - 1)\left(\frac{1 - d}{\alpha}\right)^{\frac{\alpha}{\alpha - 1}}. \tag{7b}$$

Equation (7a) indicates that the creditor's expected payoff decreases as d approaches 0 from above or approaches 1 from below. Furthermore, it is maximized at

$$\bar{d} = \frac{\alpha - 1}{\alpha} \in (0,\ 1), \tag{8}$$

implying that, so long as $d > \bar{d}$ and the debtor country always acts as specified by its best response function (6), the creditor can increase its own expected payoff by reducing the amount of remaining debt that needs to be paid off. Furthermore, since Eq. (7b) implies that the debtor's expected payoff is a decreasing function of d, reducing debt burden also helps raise the debtor's expected payoff.

Since the objective of our study is to investigate which relief scheme between debt forgiveness and debt buyback is more effective in inducing investment, the following analysis focuses on the case where $d > \bar{d}$ or $(D - R)/A > (\alpha - 1)/\alpha$. In other words, we will focus on the case in which the debtor country has debt overhang and thus is on the downward-sloping segment of the debt Laffer curve. Therefore, it is in the creditor's best interest to reduce the debtor country's debt burden.

2.1 A two-stage game with debt forgiveness

Consider the following two-stage game. During the first stage, the creditor has the option to forgive some or all of their debt claims. During the second stage, the debtor chooses the probability p that would generate extra resource transfers as described previously. Let F denote the amount of debt being forgiven in the first stage. After subtracting F from the initial outstanding debt D, the expected debt repayment becomes

$$V_C(F) = \begin{cases} (1-p)R + p(D-F) & \text{if } F \leq D - R, \\ D - F & \text{otherwise.} \end{cases} \tag{9}$$

Clearly, the creditor does not benefit from eliminating all of the remaining debt $(D - R)$ and thus in equilibrium, $V_D(F)$ depends on the debtor's choice of probability p as described in Eq. (6) with $d \equiv \frac{D-R-F}{A}$. Furthermore, we know from Eq. (8) that the expected debt repayment is maximized when d equals to $\bar{d}$. Therefore, the optimal amount of debt relief in the first stage is

$$F^* = D - R - \frac{\alpha - 1}{\alpha} A. \tag{10}$$

We conclude this section by noting that if the debtor chooses a best response strategy as given by Eq. (6), then on the equilibrium path the creditor forgives $F = F^*$ in the first stage and the debtor chooses $p = p^*(\bar{d}) = \alpha^{\frac{-2}{\alpha-1}}$ as the probability of generating extra income in the second stage. After substituting these strategies into Eqs. (7a) and (7b), the equilibrium expected payoffs are:

$$V_C^* = R + A(\alpha - 1)\alpha^{\left(\frac{-(\alpha+1)}{\alpha-1}\right)}, \tag{11a}$$

and

$$V_D^* = A(\alpha - 1)\alpha^{\left(\frac{-2\alpha}{\alpha-1}\right)}. \tag{11b}$$

2.2 A two-stage game with debt buyback

Now consider an alternative relief scheme to be used in the first stage of the game described previously. Rather than forgiving debt, the creditor has an option to sell their debt claims back to the debtor at a discount price $P < 1$ for each nominal unit of the outstanding debt. Since buying back the debt decreases the fraction of the extra reserves that must be used to service the remaining debt, it is in the debtor's best interest to buy back as much debt as possible in this stage. It follows that if $P \geq R/D$, the creditor would receive a payment of R and the debtor would have $D - R/P$ of debt remaining. On the other hand, if the price is sufficiently low, i.e., $P < R/D$, the debtor would be able to buy back all of its debt at a total price of PD.

Let $V_C(P)$ denote the creditor's expected payoff that includes the revenue from selling their debt claims in stage 1 and possibly a remaining debt repayment in stage 2:

$$V_C(P) = \begin{cases} R + p(D - R/P) & \text{if } P \geq R/D, \\ PD & \text{otherwise.} \end{cases} \tag{12}$$

As the creditor does not benefit from selling the debt back to the debtor for less than R, the creditor would choose $P \geq R/D$ in equilibrium. Therefore, the expected debt repayment would again depend on the debtor's choice regarding p. Since the debtor would use all of its initial resources R to buy back R/P of its initial debt, its expected payoff is:

$$V_D(P) = p\left[A - \left(D - \frac{R}{P}\right)\right] - Ap^{\alpha} = A[p(1-d) - p^{\alpha}], \tag{13}$$

where $d \equiv \frac{D-R/P}{A}$ is now the fraction of the extra resources (A) that must be used to service the remaining debt $(D - R/P)$. By equating d to $\bar{d}$ from Eq. (8), we conclude that if the debtor chooses a best response strategy as given by Eq. (6), then in equilibrium the creditor would sell its debt claims at a price $P = P^*$, where

$$P^* = \frac{R}{D - A\left(\frac{\alpha-1}{\alpha}\right)}, \tag{14}$$

and the debtor would choose $p = p^*(\bar{d}) = \alpha^{\frac{-2}{\alpha-1}}$. After substituting these strategies into Eqs. (12) and (13), the equilibrium payoffs of the creditor and the debtor under the Buyback treatment are the same as those described in Eqs. (11a) and (11b). That is, the equilibrium outcomes are identical for both creditor and debtor regardless of the debt relief being in the form of forgiveness or buyback.

3 The experiment

The experiment consisted of six sessions conducted at the University of Canterbury, Christchurch, New Zealand from March to May 2007.[7] There were 96 subjects in total recruited from large first year courses as well as a university wide distribution of recruitment posters.[8] Each subject participated in only a single session of the study. Although some of the subjects may have participated in previous economics experiments, all were inexperienced in the institution designed for this particular study. Subjects were paid according to the predetermined and publicly known conversion rate (30 francs = NZ$1) that was identical for all subjects across sessions. On average, sessions lasted 2 h and subjects earned an average of NZ$25.41 (roughly US$17.64).[9] The experiment was computerized using the Ztree software package developed at the Institute for Empirical Research in Economics at the University of Zurich.[10]

3.1 Parameters

For both treatments, the initial reserves R were 40 francs and the outstanding debt D was 120 francs. Debtor's disutility function for striving for additional income, shown in Table 1, was a discrete approximation of Eq. (1) with parameters $A = 80$ francs and $\alpha = 2$. Subjects were paid the actual outcomes based on additional income A being realized or not (given the probability p chosen by the debtor). Given these parameters, we predict that the creditor would forgive 40 francs ($F^* = 40$) under the Forgive treatment and sell each 1-franc debt claim at a price of 0.5 back to the debtor ($P^* = 0.5$) under the Buyback treatment. $P^* = 0.5$ implies that the debtor is able to buy back 80 francs of debt at a total cost of 40, which is equivalent to relieving 40.[11] The debtor would choose to incur a cost so that the probability that additional income A realizes is 30%($p* = 30\%$). Finally, the creditor earns an expected payoff of 52 francs $\left(V_C^* = 52\right)$ and the debtor earns an expected payoff of 5 francs $\left(V_D^* = 5\right)$.

Table 1 Relationship between effort cost and probability of success

Prob. of success	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Effort cost (in francs)	0	1	3	7	13	20	29	39	51	65	80

[7] Experiment instructions are available upon request.

[8] The first year courses consisted of accounting, economics, finance, law, management, mathematics, and statistics. The direct recruitment from these classes as well as the university wide recruitment poster campaign provided us a large, diverse database of potential experiment participants comprising approximately 8% of the entire student body. The management of the recruitment process is done via the ExLab (http://exlab.bus.ucf.edu/) recruitment and subject management program.

[9] The adult minimum wage in New Zealand at the time of the experiment was NZ$10.25 per hour and an exchange rate of NZ$1 = US$0.6943.

[10] See Fischbacher (2007) for a description of the program.

[11] Under the buy back regime, the amount of relief equals the total amount bought back minus the actual cost of the buy back.

3.2 Procedures

Each session consisted of 16 subjects that were separated into two groups of size eight representing the different types in the experiment, debtors and creditors. Subjects allocated themselves to a group by their choice of an unmarked computer terminal in the laboratory. Once everyone was seated, a coin was publicly flipped by one of the subjects to randomly allocate types between the two groups. In order to ensure individual decisions remained anonymous, each subject was given an ID number and all interaction between subjects took place via the computer. Each session consisted of 20 periods, which was made common knowledge to the subjects as well as the fact that for each period the rules of the game were identical.[12] In each period, a debtor was randomly matched with a creditor. The process of the random matching was common knowledge and was organized so that subjects had zero probability to being matched with the same counterpart for two consecutive periods and a very low probability of being matched with the same counterpart in period $t+2$.[13]

The experimental design consisted of two treatments in which the mechanism of debt relief was the treatment variable. In the Forgive treatment, creditors had the option to reduce the amount of debt owed to them by "forgiving" a portion or all of the debt outstanding, which removed any liability of the debtor to payback that portion of the debt. In the Buyback treatment, creditors had the option to sell debt back to the debtors at a discount. That is, they were willing to accept some fraction of a dollar for every dollar owed to them, which effectively reduced the total amount of the initial debt to be paid back.

In both treatments, debtors started each period with the $D = 120$ francs debt and $R = 40$ francs of cash, i.e., they were in a net position of -80 francs and initially unable to pay back all of the debt. A debtor was obligated to pay his outstanding debt with any cash he had available. If it was the case that debt still remained after all the debtors' cash had been exhausted, then the debtor did not incur negative earnings from the remaining outstanding debt. The debtors' only source of positive earnings was from any remaining cash after all outstanding debt was paid. Creditors started each period with a 120 franc loan to their counterpart debtor and zero cash. Thus, their only source of income was a payment on the debt that they receive from the debtor. Any outstanding debt provided them zero return.

The game played in each period consisted of two stages in which creditors and debtors sequentially made decisions. The procedures differed slightly between treatments in the first stage of the game. In the Forgive treatment, creditors decided how much if any of the outstanding debt that they wanted to forgive. They could choose to forgive any amount from 0 to 120 francs in 10 franc increments. The decision was made by selecting one of the 13 buttons presented on the computer screen corresponding to

[12] An initial practice period, period 0, was played at the beginning of each session to allow subjects to become comfortable with the interface, specific parameters of the experiment, and process of making decisions. This practice period did not count towards their final earnings.

[13] Note that this random matching procedure is stricter that standard stranger matching in which there is a positive probability of being match with the same agent in $t + 1$. However, just as with the standard stranger matching protocol, this procedure does not completely eliminate the possibility of strategic interaction. Although, it greatly increases the difficulty of doing so.

each 10 franc increment. In the Buyback treatment, creditors chose a price that they were willing to sell 1-franc of debt back to the debtor, which ranged from 0 to 1 in 0.1 franc increments. The computer bought back as much debt as possible with the debtor's initial endowment of 40 francs at the chosen price by the creditor.[14]

The procedures in stage two of the game were the same across treatments. At the beginning of the second stage, the debtor was made aware of the cash remaining (40 francs in Forgive and dependent upon the price in Buyback) and the amount of debt still outstanding. Given this information, the debtor had the option to invest effort into production of a project that, if succeeded, paid the debtor additional 80 francs. The more effort incurred, the greater the probability of producing the project.

At the end of each period in all treatments, subjects were presented a summary screen. In both treatments, this consisted of the amount of debt remaining, effort cost incurred, rate of success, whether the project succeeded or not, and their own earnings. Specific to the Buyout and Forgive treatments, the amount forgiven and the sell price was also displayed respectively.

Subjects were paid the actual earnings based on the success of the project; therefore, it was possible for debtors to earn negative earnings in any given period. For example, in equilibrium, a project success yielded creditors and debtors 80 francs and 33 francs respectively; a failure resulted in 40 francs and −7 francs respectively. To account for this and ensure that saliency was maintained, an initial endowment of 150 francs (NZ$5.00) was provided to each subject for which positive (negative) earnings each period were added to (subtracted from).

4 Results

To eliminate the potential bias due to confusion at the beginning of the experiment and thus to focus on equilibrium behavior, we exclude the data from periods 1 to 5 in our data analysis in the following. The statistical summary of several key variables from periods 6 to 20 is given in Table 2.

Table 2 Mean and standard deviation of key variables

	Forgive	Buyback	Theoretical prediction
Relief amount	46.06 (17.71)	38.46 (19.24)	40
Project Success rate (in percent)	35.81 (23.33)	36.33 (19.24)	30
Creditor's expected payoff	49.81 (8.94)	52.58 (8.15)	52
Debtor's expected payoff	4.21 (8.89)	2.97 (7.13)	5
Number of observations	360	360	

[14] Because debtors in the Forgive treatment were not allowed to decline any portion of the relief (because it was in their best interest to accept it all), debtors in the Buyback treatment were not given an option to decide how much debt they wished to buy back either. In other words, to ensure that the two treatments are comparable with each other, debtors in the Buyback treatment only got to decide how much effort they wished to exert.

4.1 Creditors' relief decisions

To directly compare creditors' decisions between the two treatments, the amount of relief in the Buyback treatment is defined as the difference between the face value and the real cost of the debt being bought back. Figure 2a illustrates the amount of debt relief, averaged across three sessions, in each period. The black and grey solid lines represent the Forgive and Buyback treatments, respectively, and the black dash line indicates the theoretical prediction. The impression one gains from Fig. 2a is that the amount of debt relief in the Forgive treatment is generally higher than the theoretical prediction of 40 throughout all 20 periods, whereas the relief amount in the Buyback treatment, shown in Fig. 2b, is much closer to the prediction, especially during the middle course of the experiment. In other words, the debt relief amounts in the Buyback treatment appear to be more in line with the theoretical prediction.

Exactly how much more generous are the creditors in the Forgive treatment than those in the Buyback treatment? One can get an initial sense of it from Table 2 which shows that creditors relieve an average of 46.06 per period in the Forgive treatment and 38.46 in the Buyback treatment. This result, though suggestive, is rather preliminary because important factors such as group and time effects are left uncontrolled for. To investigate the treatment effect on the amount of debt relief, we adopt a GLS

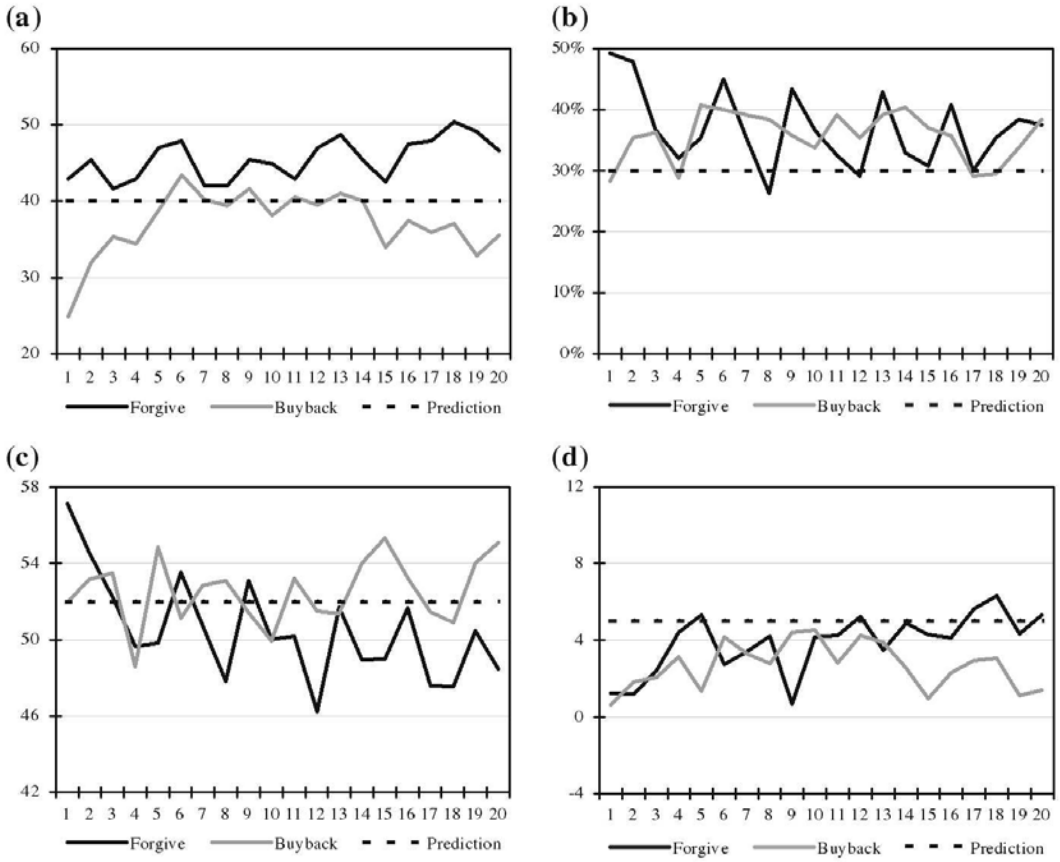

Fig. 2 Time series of the key variables. **a** Debt relief. **b** Probability of project success. **c** Expected payoff–creditor. **d** Expected payoff–debtor

Table 3 Results of GLS random-effects models

	(1) Relief amount	(2) Project success rate	(3) Creditor expected payoff	(4) Debtor expected payoff	(5) Total expected payoff
Constant	39.80*** (3.36)	9.20 (8.01)	47.71*** (3.11)	−2.56 (2.34)	44.85*** (1.48)
Period	−0.10 (0.23)	−0.18 (0.22)	−0.07 (0.09)	0.05 (0.05)	−0.01 (0.05)
Forgive dummy	7.60* (4.03)	−6.06** (2.60)	−2.41*** (0.72)	−0.60 (0.72)	−3.07*** (0.75)
Relief amount		0.83*** (0.22)	0.48*** (0.10)	−0.07 (0.07)	0.42*** (0.05)
(Relief amount)^2		−0.001 (0.002)	−0.01*** (0.001)	0.004*** (0.0006)	−0.003*** (0.0005)
Observations	720	720	720	720	720

Standard errors, shown in parentheses, are adjusted for within-session correlations
***, **, * Indicate significant at the 1%, 5%, and 10% levels, respectively

random-effects model which allows us to take advantage of the cross-sectional and time-series variation in the data. In addition, as subjects interacting with one another throughout 20 periods are more likely to provide observations that are not independent, we correct such a within-session correlation by clustering observations on the session level. As a result, the statistical significance of our estimates is less likely to be exaggerated. The results are summarized in the following.

Result 1 *There is significantly more debt relieved in the Forgive treatment than in the Buyback treatment.*

Support for Result 1 The explanatory variables included in the random-effects model are time period t and a dummy variable that equals 1 for the Forgive treatment and 0 for the Buyback treatment. The estimates are given in column (1) of Table 3. The regression result shows that, after the group and time effects are controlled for, creditors in the Forgive treatment relieved additional 7.60 francs of debt per period than in the Buyback treatment. This difference is statistically significant at the 10% level.[15]

4.2 Debtors' effort decisions

The effort exerted by debtors is reflected by their corresponding choices of the project success rate, and Table 2 shows that the average project success rate chosen between periods 6 and 20 is 35.81% in the Forgive treatment and 36.33% in the Buyback treatment.[16] In other words, despite the fact that debtors in the Forgive treatment receive

[15] We also ran a Tobit regression to account for the fact that relief amounts must be in the interval of [0, 120]. The estimates are very similar to those shown in Table 3 in that time periods continue to have an insignificant effect on relief decisions and that, on average, creditors relieve 7.66 francs more debt in the Forgive treatment than in the Buyback. This treatment difference, even after within-session correlations are corrected for, is significant at the 10% level.

[16] Given the suboptimal choices of creditors, one referee asked how deviations from their best responses actually affected debtors' expected payoffs. We found that, in the Forgive treatment, debtors could have earned an average of 7.65, rather than 4.21, had they chosen their best response strategies. In the Buyback

Table 4 Spearman rank correlations for individual debtors

Forgive 1	Debtor ID	1	2	3	4	5	6	7	8
	ρ (Relief, Effort)	0.93***	0.67**	0.91***	0.85***	0.74***	0.22	0.43	0.72***
Forgive 2	Debtor ID	9	10	11	12	13	14	15	16
	ρ (Relief, Effort)	0.91***	0.82***	0.73***	0.61**	0.61**	0.80***	0.96***	0.90***
Forgive 3	Debtor ID	17	18	19	20	21	22	23	24
	ρ (Relief, Effort)	0.14	0.78***	0.50*	0.83***	0.86***	0.43	0.44*	0.31
Buyback 1	Debtor ID	25	26	27	28	29	30	31	32
	ρ (Relief, Effort)	0.97***	0.98***	0.62***	0.91***	0.99***	0.65***	0.83***	0.86***
Buyback 2	Debtor ID	33	34	35	36	37	38	39	40
	ρ (Relief, Effort)	0.76***	0.54**	0.37	0.60**	0.47*	0.75***	0.78***	0.96***
Buyback 3	Debtor ID	41	42	43	44	45	46	47	48
	ρ (Relief, Effort)	0.58**	0.82***	0.76***	0.96***	0.73***	0.31	0.71***	0.92***

***, **, * Indicate significant at the 1%, 5%, and 10% levels, respectively

significantly more debt relief than those in the Buyback treatment, they do not seem to behave more reciprocally.

To investigate if, at the individual level, debtors in the Buyback treatment are more reciprocal, we first calculate the Spearman rank correlation between relief received and effort exerted for each individual debtor. Table 4 reports such correlation coefficients from periods 6 to 20. None of the coefficients shown in Table 4 are negative. Coefficients which are significant at least at the 10% level range between 0.44 and 0.96 in the Forgive treatment, and between 0.47 and 0.99 in the Buyback treatment. Five debtors in the Buyback treatment, as opposed to one in the Forgive, have a correlation that is greater than 0.95, indicating almost perfect correlation between the amount of debt relief and their effort choices. Overall, the Spearman rank correlation coefficient is 0.60 in the Forgive treatment and 0.66 in the Buyback treatment.

To provide further evidence for the treatment effect on debtors' effort, we adopt a GLS random-effects model that controls for time and group effects in the following.

Result 2 *Given the amount of debt relief, the chosen project success rate is significantly lower in the Forgive treatment, suggesting that debtors in the Forgive treatment are less reciprocal than those in the Buyback treatment. Furthermore, the chosen project success rate increases as the amount of relief goes up, indicating that the more creditors relieve the debt, the more debtors reciprocate.*

Support for Result 2 The following random-effects GLS model is adopted to investigate the influence of different relief schemes on debtors' effort, provided that the amount of debt relieved is controlled for:

$$\text{Prob}_{it} = \alpha + \beta_1 t + \beta_2 \text{D} + \beta_3 \text{Relief}_{it} + \beta_4 \text{Relief}_{it}^2 + u_i + \varepsilon_{it}, \tag{15}$$

Footnote 16 continued
treatment, debtors could have earned an average of 5.52, rather than 2.97, if they had behaved according to their best responses. In other words, by behaving suboptimally, debtors lost approximately 45–46% of their expected payoffs in our experiment.

where Prob_{it} is the project success rate chosen by debtor i in period t. D and Relief are defined as in Eq. (15). Column (2) in Table 3 reports the estimates for project success rate. $\hat{\beta}_2 = -6.06$, implying that, after the amount of debt relief is controlled for, the probability that the project would succeed is about 6.06 percentage points lower each period under the Forgive treatment. Also, $\hat{\beta}_3 = 0.83$ indicates that the project success rate increases by 0.83 percentage points for each additional franc of debt being relieved.

In addition to the treatment effect on the level of the chosen project success rate, it appears from Fig. 2b that the project success rate in the Forgive treatment is much more volatile from one period to another. In the following, we take debtors' individual decision as an observation and compare the proportion of optimal choices of project success rate—best responses given creditors' decisions made in stage 1—between the two treatments.

Result 3 *Conditional on creditors' relief decisions in stage 1, the proportion of best responses by debtors is significantly lower in the Forgive treatment than in the Buyback.*

Support for Result 3 In the Forgive treatment, approximately 18% of debtors' decisions from period 6 onwards are best responses to their counterparts' relief decisions, versus 27% in the Buyback. During the last five periods of the experiment, the proportions of best responses are 17% and 30% in the Forgive and Buyback treatments, respectively. A permutation test used to investigate if the proportions of optimal plays are statistically the same under the two treatments rejects the null hypothesis at the 1% level in both cases.

4.3 Expected payoffs[17]

It is perhaps not surprising from Results 1 and 2 that creditors turn out to be better off in the Buyback than in the Forgive treatment. Debtors, on the other hand, would probably prefer debt forgiveness than buyback. Table 2 shows that the average creditors' (debtors') expected payoff from periods 6 onwards is 49.81 (4.21) in the Forgive treatment and 52.58 (2.97) in the Buyback treatment. The time series shown in Fig. 2c,d further indicates that the differences in both parties' expected payoffs between the two treatments are particularly apparent during the last ten periods.

Result 4 *Given the amount of debt relief, debt forgiveness has a significantly negative impact on creditor's expected payoff. Debtor's expected payoff, on the contrary, is not influenced by the relief scheme. Overall, after taking into account the relief amount, the total expected payoff is smaller in the Forgive treatment than in the Buyback.*

Support for Result 4 The random-effects GLS estimates for creditor's, debtor's, and total expected payoffs are given in columns (3)–(5) of Table 3.[18] Column (3) suggests

[17] Since players use expected payoffs when calculating their best responses, we use the expected payoffs, as opposed to actual payoffs, for our analysis in this section.

[18] Tobit regressions yield similar results.

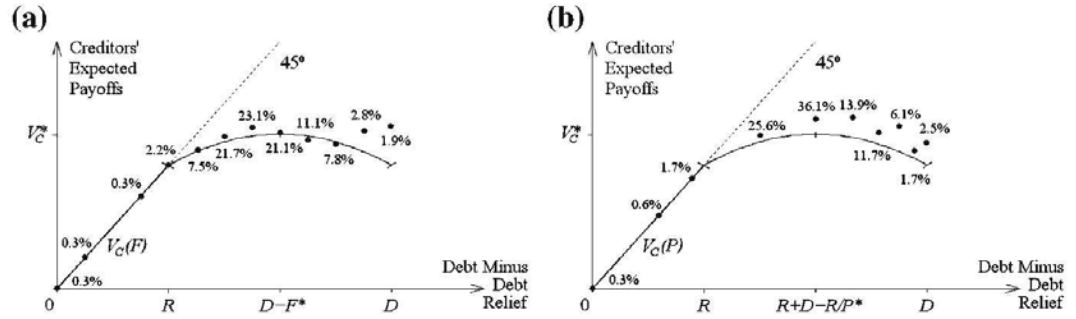

Fig. 3 Average creditors' expected payoffs in periods 6–20. **a** Forgive treatment. **b** Buyback treatment

that creditor's expected payoff increases at a decreasing rate as he relieves more debt. More importantly, once the amount of relief is being controlled for, debt forgiveness reduces creditor's expected payoff by an average of 2.41 francs per period compared to debt buyback. Column (4) indicates that, after taking the relief amount into account, relief scheme has no significant impact on debtor's expected payoff. Finally, column (5) shows that the total expected payoff is about 3.07 francs smaller in the Forgive treatment than in the Buyback. In other words, compared to debt buyback, debt forgiveness has a significantly detrimental impact for the two parties as a whole.

Contrary to the theoretical predictions, the two relief schemes proposed in our experiment turn out to generate different outcomes: creditors tend to relieve more debt in the Forgive treatment; and given the amount of relief, debtors in the Forgive treatment choose an average project success rate that is significantly lower than that in the Buyback treatment. Although it is beyond the scope of this study to fully explain these behavioral differences, a possible explanation, in our opinion, is that debtors in the two relief schemes tend to respond differently toward less generous creditors. To see this, we present the mean creditors' expected payoffs conditional on the difference between the initial debt and the relief in Fig. 3. The percentages of creditors' relief decisions and the theoretical debt Laffer curve are also shown in the figure. After excluding a few outliers on both ends of the Laffer curve that comprise less than 5% of the total observations, it can be seen from the figure that creditors' expected payoffs in the Buyback treatment are generally higher than in the Forgive treatment (consistent with Result 4). More importantly, while the maximum creditors' expected payoffs in the Buyback treatment occurs when the relief is smaller than the optimal level, creditors' expected payoffs in the Forgive treatment are maximized when the debt relief is larger than the optimum. And since creditors' expected payoffs are directly related to debtors' effort choices, these observations imply that, compared to those under the same situation in the Buyback treatment, creditors in the Forgive treatment are more likely to be punished if their relief amount is not sufficiently high.

To find support for this conjecture, we rerun the regression for debtors' effort decision depending on if the relief amount is above the optimal level or not. The results shown in Table 5 indicate that debtors' effort choices are not influenced by relief schemes when the relief amount is sufficiently high. But when the relief amount is relatively low, debtors in the Forgive treatment punish those "stingy" creditors by choosing a project success rate that is 9.40 percentage points lower than in the

Table 5 Determinants of project success rate

	Project success rate	
	Relief amount >40	Relief amount ≤ 40
Constant	14.83 (12.00)	17.61* (10.20)
Period	−0.12 (0.22)	−0.30 (0.26)
Forgive dummy	−3.86 (5.41)	−9.40*** (1.68)
Relief amount	0.80*** (0.29)	0.25 (0.52)
(Relief amount)^2	−0.002 (0.002)	0.01 (0.01)
Observations	300	420

Standard errors, shown in parentheses, are adjusted for within-session correlations
***, **, * Indicate significance at the 1%, 5%, and 10% levels, respectively

Buyback treatment. It is therefore not surprising that, to achieve higher payoffs, creditors in the Forgive treatment need to relieve more debt than those in the Buyback.

5 Conclusion

The issue of debt relief for impoverished countries has been a major concern of developed countries for decades. Once again, debt relief has recently come to the forefront of international importance as evidenced by "growth and responsibility in Africa" (highlighting debt relief) being labeled as an urgent issue to be addressed during the 2007 G8 Heiligendamm Summit. The general consensus is that the highly indebted countries suffering from debt overhang will be able allocate more resources towards investment thereby promoting their own growth and in turn be able to pay back more debt (i.e. benefit their creditors) if the debt burden were reduced (see, for example, Froot et al. 1989; Krugman 1989; Sachs 1989). An open question is which mechanism is best to relieve debt burden. In this paper, we employed experimental methods to study the effectiveness of two theoretically equivalent debt relief schemes, i.e. buyback and forgiveness. In the buyback scheme, debtors can buy back debt from creditors at a discount thereby reducing the total amount of debt to be paid back. Whereas in the forgiveness scheme, a creditor can directly remove the debtor's liability of repayment on a portion or all of the debt.

We find that in the Forgive treatment, creditors tend to relieve significantly more debt than in Buyback. Therefore, if the main objective is to promote debt relief from creditors, a mechanism of debt forgiveness appears to be a more effective tool. Across treatments, debtors' have a positive response to debt relief in terms of investment, and the average level of investment is more generous than theoretically predicted. Therefore, if the main objective is to stimulate investment efforts of debtors, i.e., help debtors help themselves, then the two mechanisms appear to be fairly equivalent. However, there is not significantly more investment in Forgiveness to coincide with the higher levels of relief, and debtors have significantly lower project success rates in Forgiveness once we control for differences in levels of debt relief. This suggests that the forgiveness scheme does not induce similar levels of reciprocation. Given the

poor performance of the forgiveness scheme, it is not surprising debt forgiveness has a significantly negative impact on the creditor's earnings for a given level of debt relief. Overall, the buyback scheme provides higher expected payoffs than debt forgiveness. Therefore, in terms of overall efficiency, the debt buyback mechanism is definitely superior to the debt forgiveness mechanism.

To our knowledge, this is the first experimental study to investigate debt relief, and thus we wanted to start the area of research with the simplest design possible. Now that we have acquired insights on behavior within these simple environments, we can build upon this foundation by adding more complicated and "realistic" extensions to future designs/studies. Some possibilities for future work are (1) introducing multiple creditors to allow for free-riding on the debt relief of others, (2) including multiple debtors to allow for the creation of debt relief precedents, and (3) allowing for conditional relief contracts such that debtors are required to make a credible commitment regarding specific reforms.

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