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Forgive or Buy Back: An Experimental Study of Debt Relief

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Forgive or Buy Back: An Experimental Study of Debt Relief [†]

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Abstract

A large share of the debt claims owed by the world's poorest countries has been cancelled through the HIPC (highly indebted poor countries) debt relief initiative. It is believed that, with less debt burden, the HIPC will be able to devote more resources to investment and thus promote their own growth and benefit their creditors in the long run. But does debt forgiveness really provide the best incentive for those countries who suffers from debt overhang? In this paper, we adopt experimental methods to study the impact of two different schemes for relieving debt. The two schemes we consider here are debt forgiveness and debt buyback, with the latter being more market-based since it allows indebted countries to repurchase their own debt on the secondary market at a discount. We find that creditors tend to reduce more debt when the relief takes the form of debt forgiveness than that of buyback. Debtors under the scheme of forgiveness are not significantly more reciprocal than those of buyback. After controlling for the amount of debt relief, creditors are significantly worse off under forgiveness whereas debtors are indifferent between the two schemes. Overall, debt forgiveness yields less desirable outcomes than debt buybacks.

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1. Introduction

The Jubilee Debt Campaign and some high-profiled advocates such as U2 lead singer Bono and the Dalai Lama have recently brought the international spotlight to debt relief. These debt relief campaigners have transformed developing countries' external debt issues into a moral movement: calling for 100% cancellation of the massive foreign debts owed by the world's poorest countries and demanding an end to "the scandal of poor countries paying money to the rich world."[1] Despite of these recent attentions, reducing poor countries' heavy debt burden has always been on developed countries' agenda since 1970s. Between 1976 and 1988, a group of creditor countries, known as the Paris Club, rescheduled payment deadlines for 81 countries that had difficulty servicing their debts and delayed around US$23 billion of payments. In 1996, the IMF and the World Bank launched the HIPC Initiative, aiming to reduce the debt burdens of the most heavily indebted countries. By the end of 2005, 30 out of the 40 eligible countries had been approved for the debt reduction packages, and about US$37 billion of debt, in present value terms, was being reduced through the HIPC relief programs. The question is: Will debt relief be able to help heavily indebted countries and at the same time benefit their creditors?

Krugman (1988) suggests 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. The presence of a debt overhang makes a debtor country less likely to attract new creditors and thus force it to forgo profitable investment projects that otherwise would have be undertaken if the overhang were absent. In other words, a debt overhang acts as an implicit tax on investment, and would thus impede growth and increase the probability of repudiation in the long run. The expected value of repayments decreases as a

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

result. Krugman (1989) uses a debt Laffer curve to describe the relationship between the nominal value of a country's debt and the expected value of repayment. A country 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. The debt Laffer curve becomes downward sloping accordingly.

The existence of debt overhang and thus debt Laffer curve provide a legitimate reason, at least in theory, for creditors to write off some of the debt in order to bring debtor countries back to the upward sloping segment of the debt Laffer curve and recoup part of their debt claims. But which relief scheme is more effective in reaching the goal? 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 the secondary market usually at a substantial discount. 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 would generate the same outcomes, meaning that both debtor and its creditors would be indifferent, in expected terms, between debt forgiveness and debt buybacks.

The objective of this paper is to investigate the effectiveness of debt forgiveness and debt buybacks in a laboratory environment. We construct an experiment in which debtors countries suffer from debt overhang. We compare the amount of debt relief made by creditors, debtors' willingness to invest in order to increase the likelihood to repay the debt, and the expected payoffs of both debtors and creditors under these two relief schemes. As reported in detail below,

creditors under the scheme of forgiveness tend to reduce significantly more debt than those under the buyback scheme. Debtors, on the other hand, do not reciprocate significantly more under the scheme of forgiveness. After controlling for the amount of debt relief, creditors are significantly worse off under forgiveness whereas debtors are indifferent between the two schemes. Overall, debt forgiveness yields less desirable outcomes than debt buybacks.

The rest of the paper is organized as follows. A simple theoretical model that is built on Krugman (1989) is presented in Section 2. Section 3 describes the experimental design and procedures. The results are reported in Section 4. Section 5 concludes the paper.

2. The Model

We construct a simple model of debt overhang based on Krugman (1989). Consider a risk neutral debtor country that has inherited a debt whose nominal value (D) is larger than the country's current resources (R). With some uncertainty, the debtor country can generate more resources or income to repay its debt. For simplicity, let us assume that, with probability p, the debtor could generate extra amount of resources (A), where $A \geq D-R$, so that the extra amount of resources is sufficient to pay off $D-R$. With probability $1-p$, no extra resources will be realized and thus the debtor will not be able to fully service its debt.

The effort to generate more resource transfer is costly. More specifically, we assume that the debtor's disutility to strive for more resources, denoted by e, is a convex function of the probability p that the good outcome would occur:

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

where $a > 1$.

Given p, we can solve for the expected value of the debt payments (EV) from debtor to the creditor. Since the debtor cannot pay more than the total amount of resources available ($R + A$) in the good state or in the bad state (R),

$$EV = p \min\{R+A, D\} + (1-p) \min\{R, D\} = R + p\,(D-R)\,. \tag{2}$$

On the other hand, the debtor's expected payoff (EU) equals the expected total resources $(R + pA)$ minus the expected debt payments to its creditor (EV) minus its disutility for striving for more resources (e):

$$EU = R + pA - EV - e\,. \tag{3}$$

Finally, let d denote the fraction of additional reserves (A) that the debtor country must use to pay off $D - R$. That is,

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

After substituting equations (1), (2) and (4) into equation (3), the debtor's expected payoff becomes:

$$EU = p(A+R-D) - Ap^{a} = Ap(1-d-p^{a-1})\,. \tag{5}$$

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

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

It is clear from equation (6) that the probability that the extra resources would be generated and thus the chance that the debt will be fully repaid decrease with $D - R$.

Substituting the debtor's best response function into equation (2) yields the expected debt repayment:

$$EV^*(d) = R + Ad\left(\frac{1-d}{a}\right)^{\frac{1}{a-1}}. \quad (7)$$

Equation (7) indicates that as d approaches 0 from above or 1 from below, the expected debt repayment to the creditor decreases toward R. Furthermore, the expected debt repayment is maximized at

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

implying that the creditor (as well as the debtor) can actually increase the expected debt repayment by reducing part of the debt as long as $d > \bar{d}$.

Since the objective of our study is to investigate which of the two relief mechanisms between debt forgiveness and debt buyback would be more effective, we will focus our discussion assuming that $d > \bar{d}$ or $(D-R)/A > (a-1)/a$ in the following analysis. In other words, we will assume that, in Krugman's words, the debtor country is on the downward-sloping segment of the debt Laffer curve, and therefore it is in the creditor's own benefit 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

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

Clearly, the creditor does not benefit from eliminating all of the initial debt overhang ($D - R$) and thus in equilibrium, EV_F depends on debtor's choice of probability p as described in equation (6). Furthermore, we know from equation (8) that expected debt repayment is maximized when the fraction of the extra resources that the debtor must use to service its remaining debt in the second stage equals to $\bar{d}$. Therefore, the optimal amount of debt relief in the first stage is

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

We conclude this section by noting that if the creditor is represented by a single decision-maker who maximizes the total expected debt repayment (EV_F), then in equilibrium the creditor should forgive $F = F^*$ in the first stage and the debtor should choose $p = p^*(\bar{d})$ to generate extra income in the second stage. After substituting these strategies into equations (9) and (3), the equilibrium payoffs can be simplified to:

$$EV_F^* = R + p^*(\bar{d})\frac{a-1}{a}A, \tag{11a}$$

$$EU^* = \left[p^*(\bar{d})\frac{1}{a} - p^*(\bar{d})^a \right] A. \tag{11b}$$

2.2 *A Two-Stage Game with Debt Buyback*

Consider now an alternative relief mechanism to be used in the first stage of the game described previously. Rather than forgiving debt, the creditor has the option to sell their debt claims back to the debtor at a price $P < 1$ for each nominal unit of the outstanding debt. Clearly, since buying back the debt decreases the fraction of the extra reserves that must be used to

service the remaining debt, the debtor would benefit by buying as much debt as possible. It follows that if $P>R/D$, the creditor would receive a payment of *R* and the debtor would have $D-R/P$ of debt remaining. On the other hand, if $P\leq R/D$, then the debtor would be able to buy back all of its debt at a total price of *PD*.

Let EV_B denote the total expected payment to the creditor, including the revenue from selling their debt claims in stage 1 and possibly a debt repayment in stage 2:

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

As the creditor does not benefit from selling the debt back to the debtor for less than *R*, the creditor would choose $P>R/D$ in equilibrium. Therefore, the expected debt payment 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:

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

where *d* is the fraction of the extra resources (*A*) that must be used to service the remaining debt ($D-R/P$). By equating $(D-R/P)/A$ to $\bar{d}$ from equation (8), we conclude that if the creditor is represented by a single decision-maker who maximizes EV_B, then in equilibrium the creditor would choose to sell their debt claims at a price $P=P^*$, where

$$P^*=\frac{R}{D-A+A/a}, \tag{14}$$

and the debtor would choose $p=p^*(\bar{d})$. After substituting these strategies into equations (12) and (13), the equilibrium payoffs of the creditor and the debtor under the Buyback treatment are

exactly the same as those described in equations (11a) and (11b). That is, in equilibrium, both creditor and debtor are indifferent between debt relief 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. There were 96 subjects in total recruited from large first year courses as well as a university wide distribution of recruitment posters.[2] 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 two hours and subjects earned an average of NZ$25.41 (roughly US$17.64).[3] The experiment was computerized using the Ztree software package developed at the Institute for Empirical Research in Economics at the University of Zurich.[4]

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

[2] 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.

[3] 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.

[4] Please see Fischbacher (2007) for a description of the program.

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.[5] In each period, a debtor was randomly matched with a creditor. The process of the random matching was common knowledge and was such 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 $t + 2$.[6]

The experimental design consisted of two treatments in which the mechanism of debt relief was the treatment variable. In the first treatment (Forgive), 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 second treatment (Buyback), 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, creditors started each period with a 120 franc loan to their counterpart debtor and zero cash. Debtors started each period with the 120 franc debt and 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. The creditors' only source of income was a payment on the debt that they receive from the debtor. Any outstanding debt provided them zero return. 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, the debtor did not incur negative earnings from the remaining

[5] 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 earnings.

[6] Note that this random matching procedure does not completely eliminate the possibility of strategic interaction. However, it great increases the difficulty of doing so.

outstanding debt. The debtors' only source of positive earnings was from any remaining cash after all outstanding debt was paid.

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 on the computer screen corresponding to each 10 franc increment.[7] 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.

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 monetary effort into production of a project that, if succeeded, paid the debtor an additional 80 francs. The more monetary effort incurred, the greater the probability of producing the project. The relationship between effort cost and probability of success is presented in Table 1. It should be noted that the monetary effort cost was not bounded by the cash on hand by the debtor. The debtor could incur any level of monetary effort they desired, which was simply subtracted from the period earnings. Therefore, it was possible for the debtor to earn negative earnings in any given period. To account for this and ensure that saliency was maintained, an initial endowment of 150 francs

[7] Pictures of the Ztree screens for each treatment are presented in the Appendix.

(NZ$5.00) was provided to each subject for which positive (negative) earnings each period were added to (subtracted from).

[Table 1: About Here]

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, monetary 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.

For both treatments, the initial reserves R were 40 francs and the outstanding debt D was 120 francs. Debtor's disutility function was a discrete approximation of equation (1) with parameters A = 80 francs and a = 2. Subjects were paid the actual outcomes based on additional reserves A being realized or not (given the probability p chosen by the debtor). Given these parameters, in equilibrium F^* = 40 francs, P^* = 50%, p^* = 30%, EU^* = 5 francs and EV^* = 52 francs.

4. Results

The time series of the average amount of debt relief, project success rate, debtor's expected payoff, creditor's expected payoff, and total expected payoff are shown in Figures 1(a) – 1(e). The black and grey dashed lines are for the Forgive and Buyback treatments, respectively. Additionally, the statistical summary of these key variables from period 1 to 20 over all three sessions for the two treatments is given in Table 2.

[Figures 1(a) – 1(e) and Table 2: About Here]

From Figure 1(a), it is obvious that the amount of debt relief is higher under the Forgive treatment than under the Buyback treatment for all 20 periods. We can see from Table 2 that creditors relieve an average of 45.54 per period under the Forgive treatment and 37.11 under the Buyback treatment. Taking creditors' each individual play as one independent observation, a Mann-Whitney rank sum test of the two treatments provides a *p*-value of 0.0000, implying that we can reject the hypothesis that the two distributions are the same at any conventional levels. This result, though suggestive, is still preliminary in the sense that important factors such as group and time effects are not taken into account. In the following, we adopt a panel data approach to investigate the treatment effect on the amount of debt relief.

RESULT 1: *There is significantly more debt being relieved under the Forgive treatment than under the Buyback treatment.*

SUPPORT FOR RESULT 1: To see if the amount of debt relief is significantly different under the two treatments, we use the following random-effects GLS model which allows us to take full advantage of the cross-sectional and time-series variation in the data:

$$Relief_{it} = a + b_1 t + b_2 D + u_i + e_{it}, \tag{15}$$

where $Relief_{it}$ is the amount of debt that creditor i relieves in period t, D is a dummy variable that equals 1 for the Forgive treatment and 0 for the Buyback treatment, u_i is a subject-specific error term, and e_{it} is the residual. Since subjects interacting with one another throughout 20

periods are more likely to provide observations that are not independent, we correct such an intra-class correlation by clustering observations on the session level. As a result of the cluster-robust standard errors, the statistical significance of our estimates is less likely to be exaggerated. The results are given in column (1) of Table 3. It is clear that, after the group and time effects are controlled for, creditors reduce on average 8.43 more debt under the Forgive treatment than under the Buyback treatment. This difference is statistically significant at the 10% level. ¦

[Table 3: About Here]

In terms of debtors' decisions, the first impression from Figure 1(b) is that debtors across treatments tend to reciprocate too much. The average project success rate over all sessions and all 20 periods is 36.92% under the Forgive treatment and 35.73% under the Buyback treatment. A one-sided sign test that is distribution-free is adopted to see if the median of the project success rate under each of the two treatments is significantly different from the theoretical prediction of 30%. Taking each play as one independent observation, both medians are significantly higher than 30% at all conventional levels (p-value = 0.0000 and 0.0000 for Forgive and Buyback, respectively).

Despite the fact that debtors under the Forgive treatment receive significantly more debt relief than those under the Buyback treatment, Figure 1(b) shows that they do not seem to be particularly more reciprocal. In fact, we cannot reject the hypothesis that the two distributions are the same given a p-value = 0.3654 from a Mann-Whitney rank sum test. Nonetheless, after taking the amount of relief into account, the project success rate under the Forgive treatment

turns out to be significantly less than that under the Buyback. Result 2 summarized in the following provides such a support.

RESULT 2: *The project success rate increases as the amount of relief goes up, indicating that the more the creditor relieves debt, the more the debtor reciprocates. Furthermore, the project success rate is significantly smaller under the Forgive treatment once the amount of debt relief is controlled for.*

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:

$$Prob_{it} = a + b_1 t + b_2 D + b_3 Relief_{it} + b_4 Relief_{it}^2 + u_i + e_{it}, \qquad (16)$$

where $Prob_{it}$ is the project success rate chosen by debtor *i* in period *t*. *D* and *Relief* are defined as in equation (15). The estimates are provided in column (2) of Table 3.Column (2) in Table 3 reports the estimates for project success rate. $\hat{b}_2 = -4.88$ implies that, after the amount of debt relief is controlled for, the probability that the project would succeed is about 4.88 percent smaller each period under the Forgive treatment. Also, $\hat{b}_3 = 0.87$ and $\hat{b}_2 = -0.002$ indicate that the project success rate is a concave function of the relief amount.

In addition to the treatment effect on the level of the project success rate, it appears from Figure 1(b) that the project success rate under the Forgive treatment is much more volatile in response to changes in amount of debt relief. In other words, debtors under the Forgive treatment seem to have more troubles optimizing the amount of effort that they would like to exert.

RESULT 3: *Debtor's effort in terms of the project success rate exhibits greater volatility from one period to the next under the Forgive treatment.*

SUPPORT FOR RESULT 3: We first define a variable Y's volatility from period *t*-1 to period *t* as the percentage change in Y_t. That is, $Volatility_t^Y = \frac{Y_t - Y_{t-1}}{Y_{t-1}} * 100$. We then analyze the following random-effects GLS model to examine the volatility of the project success rate:

$$Volatility_{it}^{Prob} = a + b_1 t + b_2 D + b_3 Volatility_{it}^{Relief} + b_4 D \times Volatility_{it}^{Relief} + u_i + e_{it}.$$

The results, reported in Table 4, suggest that for each one percentage increase in debt relief between period *t* and *t*+1, effort costs increase by an average of 0.47 percent under the Buyback treatment and 0.75 percent under the Forgive treatment. The difference of 0.28 percent is statistically significant.

[Table 4: About Here]

As a result of the above finding, it is not surprising that debtors and creditors appear to be better off under the Forgive and Buyback treatments, respectively, in Figure 1(c) and Figure 1(d). Would these non-statistical observations survive under more rigorous tests? We investigate players' expected payoffs in the following.

RESULT 4: *Given the amount of debt relief, debt forgiveness has a significantly negative impact on creditor's expected payoff but not on debtor's expected payoff. Overall, the expected payoff is smaller under the Forgive treatment than under the Buyback treatment.*

SUPPORT FOR RESULT 4: The random-effects GLS estimates for debtor's, creditor's and total expected payoffs are given in columns (3) – (5) of Table 3. We can see from column (3) that debtor's expected payoff is actually negative when the amount of debt relief is relatively small, and it increases at an increasing rate as the creditor relieves more and more debt. Given the amount of debt, debtor is slightly worse off under the Forgive treatment, as suggested by the negative estimate of b_2, but such an adverse situation is not significant. Creditor's expected payoff, shown in column (4), is an increasing function of debt relief only when the reduction is relatively small. Creditor would eventually become worse off if he reduces too much debt for the debtor. After taking the amount of debt relief into account, Forgive treatment reduces creditor's expected payoff by an average of 1.71 per period. Finally, column (5) indicates that the Forgive treatment has a significantly detrimental impact for the two parties as a whole. ¦

5. Conclusion

The issue of debt relief for heavily indebted 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 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. 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, creditors can sell debt back to

debtors 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 outstanding debt.

We find that under the forgiveness scheme, creditors tend to relieve significantly more debt than under the buyback scheme. The debtors' response to debt relief in terms of investments level is more generous than theoretically predicted across treatments, but not significantly more under the forgiveness scheme to coincide with the higher levels of relief. Under the forgiveness scheme, the level of investment into the project is significantly more volatile in response to changes in debt relief implying that debtors have more difficulty optimizing effort allocation under this scheme. In relation to the success rates of the project, the success rates increase at a decreasing rate as the level of debt relief increases across treatments. However, debtors have significantly lower project success rates under the forgiveness scheme once we control for differences in levels of debt relief. 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.

References

Fischbacher, U., “z-Tree: Zurich Toolbox for Ready-made Economic Experiments,” *Experimental Economics*, 2007, 10(2), 171-178.

Krugman, P., “Financing vs. Forgiving a Debt Overhang,” *Journal of Development Economics*, 1988, 29, 253-268.

Krugman, P., “Market-Based Debt Reduction Schemes.” In Jacob A. Frenkel, Michael P. Dooley, and Peter Wickham, eds., *Analytical Issues in Debt*, 1989, Washington D.C.: International Monetary Fund.

Table 1: Relationship between Effort Cost and Probability of Success

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

Table 2: Mean and Standard Deviation of Key Variables

	Forgive	**Buyback**	**Theoretical Prediction**
Relief Amount	45.54 (18.19)	37.11 (20.08)	40
Project Success Rate (in percent)	36.92 (22.93)	35.73 (19.84)	30
Debtor's Expected Payoff	3.89 (8.82)	2.68 (7.35)	5
Creditor's Expected Payoff	50.53 (9.11)	52.54 (8.48)	52
Total Expected Payoff	54.42 (6.28)	55.22 (5.52)	57
Number of Observations	480	480	

Table 3: Results of GLS Models with Random Effects

	(1) Relief Amount	**(2) Project Success Rate**	**(3) Debtor's Expected Payoff**	**(4) Creditor's Expected Payoff**	**(5) Total Expected Payoff**
Constant	35.08***	10.54**	–2.60*	48.40***	45.65***
	(3.01)	(4.89)	(1.35)	(1.88)	(1.12)
Period	0.19	–0.33	0.07**	–0.15*	–0.08
	(0.16)	(0.22)	(0.03)	(0.09)	(0.06)
Forgive Dummy	8.43*	–4.88**	–0.73	–1.71**	–2.51***
	(4.53)	(2.54)	(0.73)	(0.74)	(0.74)
Relief Amount		0.87***	–0.07	0.50***	0.43***
		(0.11)	(0.05)	(0.06)	(0.03)
$(\text{Relief Amount})^2$		–0.002**	0.004***	–0.01***	–0.003***
		(0.001)	(0.0004)	(0.0006)	(0.0004)
Observations	960	960	960	960	960

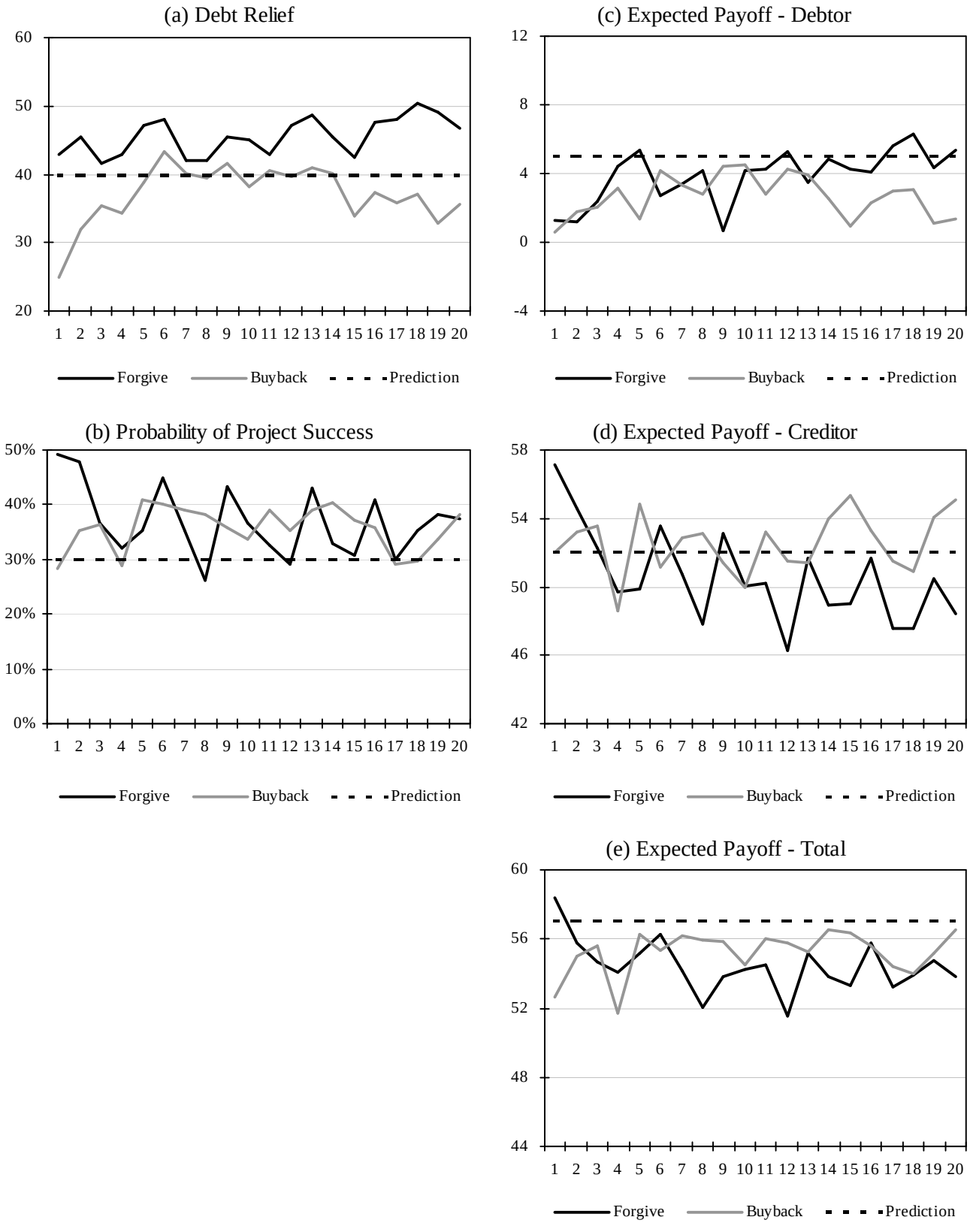
Notes: The robust standard errors, shown in parentheses, were adjusted for clustering on the subject level. Statistical significance indicated by *** for the 1% level, ** for the 5% level, and * for the 10% level.

Table 4: Random-Effects GLS Estimates for the Volatility in Effort Cost

	Volatility in Effort Cost
Constant	51.93 (51.59)
Period	5.56 (3.61)
Forgive Dummy	34.62 (43.50)
Volatility in Relief	1.92*** (0.11)
Forgive Dummy × Volatility in Relief	1.03** (0.54)
Observations	960

Notes: The robust standard errors, shown in parentheses, were adjusted for clustering on the session level. Statistical significance indicated by *** for the 1% level, and ** for the 5% level.

Figure 1: Time Series of the Key Variables



Appendix: Instructions

Instructions for Experiment (Forgive Treatment)

March 2007

1. General Instructions

This is an experiment studying decision-making. The instructions are simple and if you follow them carefully and make good decisions, you might earn a considerable amount of money which will be paid to you in cash at the end of the experiment. It is therefore very important that you read these instructions with care.

It is prohibited to communicate with other participants during the experiment. Should you have any questions please ask us. If you violate this rule, we shall have to exclude you from the experiment and from all payments.

During the experiment your earnings will be calculated in francs. At the end of the experiment the total amount of francs you have earned will be converted to NZ dollars at the following rate:

30 francs = $1

There are two types of participants in the experiment, Type A and Type B. You have been randomly assigned a type, as indicated on top of this instruction sheet. In each period, you will be paired with another participant whom we will call your counterpart. Each pair of two consists of a Type A and a Type B participant. In other words, if you are Type A, your counterpart will be Type B, and vice versa.

The experiment is divided into 20 periods. The experiment is designed so that you will be randomly matched with a counterpart each period, but never with the same counterpart two periods in a row.

2. Detailed Instructions

2.1 Endowment

At the beginning of each period, a Type A participant is endowed with 120 francs of debt owed to Type B and 40 francs of cash balance. A Type B participant, other than the 120 francs loaned to Type A, is endowed with nothing else.

Notice that it is impossible for Type A to pay off all his debt at the beginning of any given period. Nonetheless, Type A will be given an opportunity to undertake a project that, when succeed, will generate extra 80 francs at the end of the period and Type A can thus pay off his debt. There is a chance that the project will fail and, as a result, 80 francs will not be realized.

To increase the chance that the project will succeed, Type A will need to make an effort which comes with a monetary cost. The following table provides the relationship between the effort cost (in francs) and the probability that the project will succeed (the rate of success). For example, if Type A decides not to make any effort and thus incur no cost, the probability that the project will succeed is 0%. On the other hand, if Type A is willing to incur 80 francs of effort cost, the probability that the project will succeed becomes 100%. The rate of success, as

indicated by the table, increases with the effort cost. How the effort cost affects Type A's payoff will be explained in Section 3.

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

2.2 Decisions

In each period, the game is divided into two stages in which the two counterparts take turns to make their decisions:

Stage 1: In Stage 1, Type B, as the creditor, has to decide how much, if any, of the 120-franc loan that he is willing to forgive. That is, Type B can allow his Type A counterpart to pay off only part of the debt.

Stage 2: After the creditor decides how much, if any, of Type A's debt is forgiven, Type A decides how much effort cost he is willing to incur.

After Stage 2, the computer system will decide if the project succeeds or not given the project's success rate determined by Type A's effort cost.

3. Type A's Period Payoff

Type A's period payoff depends on three factors: (1) his effort cost, (2) if the project succeeds, and (3) how much debt is remaining. Note that the amount of remaining debt equals the initial debt (120 francs) minus the amount of debt forgiven (could be zero).

- **If the project succeeds:**

  The extra income of 80 francs will be realized if the project succeeds. Under such a circumstance, Type A's period payoff equals the initial cash balance (*40 francs*) + extra income generated by the successful project *(80 francs*) – remaining debt (*could be 120 francs if no debt is forgiven*) – effort cost. That is,

  Type A's payoff if the project succeeds
  = 120 – remaining debt – effort cost

- **If the project fails:**

  The extra income of 80 francs will not be realized if the project fails. Under such a circumstance, the maximum amount of debt Type A can pay off is 40 francs (*his initial cash balance*). Therefore,

  Type A's payoff if the project fails but the remaining debt is less than 40
  = 40 – remaining debt – effort cost

  Type A's payoff if the project fails but the remaining debt is at least 40
  = 40 – 40 (*the maximum amount of debt Type A can pay off*) – effort cost
  = – effort cost

Example 1: Suppose that Type A has incurred 39 francs to increase the project's success rate to 70% and that Type B has forgiven 90 francs of Type A's debt. The remaining debt for Type A is 120 – 90 = 30. If the project succeeds, Type A's payoff is 120 – 30 – 39 = 51 francs. If the project fails, Type A's payoff becomes 40 – 30 – 39 = –29 francs. Note that since the project's success rate is 70%, it is more likely for Type A to make 51 francs than to lose 29.

Example 2: Suppose that Type A has incurred 39 francs to increase the project's success rate to 70% and that Type B has forgiven 20 francs of Type A's debt. The remaining debt for Type A is 120 – 20 = 100. If the project succeeds, Type A's payoff is 120 – 100 – 39 = –19 francs. If the project fails, Type A's payoff becomes 0 – 39 = –39 francs. Note that since the project's success rate is 70%, it is more likely for Type A to lose 19 francs than to lose 39.

You may use the **Payoff Sheet** to help you find out Type A's period payoffs. The small table at the top right corner of the sheet is used to remind participants the relationship between Type A's effort cost and the project's success rate. The two big payoff tables on the top are Type A's payoff tables. The table on the left is for the case when the project succeeds, and the table on the right is for the case when the project fails. The first row labeled *Type A's Effort Cost* lists all the possible effort costs that Type A can incur. The first column labeled *Debt Forgiven* lists the amount of debt Type B can forgive. The second column labeled Debt Remaining equals 120 – Debt Forgiven. The numbers in bold are the possible payoffs for Type A.

4. Type B's Period Payoff

Type B's period payoff depends on only two factors: (1) if Type A's project succeeds, and (2) how much Type A's debt is remaining. Note that Type A's remaining debt equals Type A's initial debt (*120 francs*) minus the amount of debt forgiven by Type B (*could be zero*).

- **If the project succeeds:**

  The extra income of 80 francs will be realized if the project succeeds. Under such a circumstance, Type A must pay off all his remaining debt, and thus Type B's period payoff simply equals Type A's remaining debt (*could be 120 francs if no debt is forgiven*).

  Type B's payoff <u>if the project succeeds</u>
  = Type A's remaining debt

- **project fails:**

  The extra income of 80 francs will not be realized if the project fails. Under such a circumstance, the maximum amount of debt Type A can pay off is 40 francs (*his initial cash balance*). Therefore,

  Type B's payoff <u>if the project fails but Type A's remaining debt is less than 40</u>
  = Type A's remaining debt

  Type B's payoff <u>if the project fails but Type A's remaining debt is at least 40</u>
  = 40

Example 3: Suppose that Type A has incurred 39 francs to increase the project's success rate to 70% and that Type B has forgiven 90 francs of Type A's debt. The remaining debt for Type A is 120 – 90 = 30. If the project succeeds, Type B's payoff is 30 francs. If the project fails, Type B's payoff is also 30 francs.

Example 4: Suppose that Type A has incurred 39 francs to increase the project's success rate to 70% and that Type B has forgiven 20 francs of Type A's debt. The remaining debt for Type A is 120 – 20 = 100. If the project succeeds, Type B's payoff is 100 francs. If the project fails, Type B's payoff becomes 40 francs. Note that since the project's success rate is 70%, it is more likely for Type B to make 100 than to make 40.

You may use the **Payoff Sheet** to help you find out Type B's period payoffs. The two big payoff tables at the bottom of the sheet are Type B's payoff tables. The table on the left is for the case when the project succeeds, and the table on the right is for the case when the project fails. The first row labeled *Type A's Effort Cost* lists all the possible effort costs that Type A can incur. The first column labeled *Debt Forgiven* lists the amount of debt Type B can forgive. The second column labeled Debt Remaining equals 120 – Debt Forgiven. The numbers in bold are the possible payoffs for Type B.

5. Period Earning Sheet

At the end of each period, record your period earnings on your **Period Earnings Sheet**. The first column of the Period Earnings Sheet indicates the current period. Record the amount of debt forgiven by Type B in column 2 labeled *B's Debt Forgiven*. Record the effort cost Type A chose to incur in column 3 labeled *A's Effort Cost*. Record if the project succeeded or not in column 4 labeled *Succeed*. Record your period payoff in column 5 labeled *Your Period Payoff*.

At the beginning of the experiment, you will be given an initial endowment of 150 francs. Your total earnings for the experiment are your initial endowment (*150 francs*) plus the total period payoffs from periods 1 to 20. If your earnings from periods 1 – 20 payoffs are negative, this negative amount will be subtracted from your initial endowment.

There will be a practice period, 0, which will not count toward your final earnings.

6. Quiz

To check your understanding of the experiment, please answer the following questions.

1. Suppose that Type B decides to forgive 40 francs of Type A's debt and that Type A decides to incur 65 francs of effort cost.

   (a) What's the probability that the project will succeed (success rate)? _____
   (b) How much is Type A's remaining debt? _____ francs
   (c) What is Type A's payoff if the project succeeds? _____ francs
   (d) What is Type A's payoff if the project fails? _____ francs
   (e) Which of the above payoffs is more likely to happen to A? _____ francs
   (f) What is Type B's payoff if the project succeeds? _____ francs
   (g) What is Type B's payoff if the project fails? _____ francs
   (h) Which of the above payoff is more likely to happen to B? _____

2. Suppose that Type B decides to forgive 100 francs of Type A's debt and that Type A decides to incur 3 francs of effort cost.

   (a) What's the probability that the project will succeed (success rate)? _____
   (b) How much is Type A's remaining debt? _____ francs
   (c) What is Type A's payoff if the project succeeds? _____ francs
   (d) What is Type A's payoff if the project fails? _____ francs
   (e) Which of the above payoffs is more likely to happen to A? _____ francs
   (f) What is Type B's payoff if the project succeeds? _____ francs
   (g) What is Type B's payoff if the project fails? _____ francs
   (h) Which of the above payoff is more likely to happen to B? _____

ID #: _____ Type: _____

PERIOD EARNINGS SHEET

(1) Current Period	(2) B's Debt Forgiven	(3) A's Effort Cost	(4) Succeed (Yes/No)	(5) Your Period Payoff
0	_____	_____	_____	_____
1	_____	_____	_____	_____
2	_____	_____	_____	_____
3	_____	_____	_____	_____
4	_____	_____	_____	_____
5	_____	_____	_____	_____
6	_____	_____	_____	_____
7	_____	_____	_____	_____
8	_____	_____	_____	_____
9	_____	_____	_____	_____
10	_____	_____	_____	_____
11	_____	_____	_____	_____
12	_____	_____	_____	_____
13	_____	_____	_____	_____
14	_____	_____	_____	_____
15	_____	_____	_____	_____
16	_____	_____	_____	_____
17	_____	_____	_____	_____
18	_____	_____	_____	_____
19	_____	_____	_____	_____
20	_____	_____	_____	_____

PAYOFF SHEET

Type A's Effort Cost (francs)	0	1	3	7	13	20	29	39	51	65	80
Rate of Success	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%

Type A's Payoff if the Project **Succeeds**

Debt Forgiven	Debt Remaining	Type A's Effort Cost (francs)										
		0	1	3	7	13	20	29	39	51	65	80
0	120	*cannot happen*	**-1**	**-3**	**-7**	**-13**	**-20**	**-29**	**-39**	**-51**	**-65**	**-80**
10	110		**9**	**7**	**3**	**-3**	**-10**	**-19**	**-29**	**-41**	**-55**	**-70**
20	100		**19**	**17**	**13**	**7**	**0**	**-9**	**-19**	**-31**	**-45**	**-60**
30	90		**29**	**27**	**23**	**17**	**10**	**1**	**-9**	**-21**	**-35**	**-50**
40	80		**39**	**37**	**33**	**27**	**20**	**11**	**1**	**-11**	**-25**	**-40**
50	70		**49**	**47**	**43**	**37**	**30**	**21**	**11**	**-1**	**-15**	**-30**
60	60		**59**	**57**	**53**	**47**	**40**	**31**	**21**	**9**	**-5**	**-20**
70	50		**69**	**67**	**63**	**57**	**50**	**41**	**31**	**19**	**5**	**-10**
80	40		**79**	**77**	**73**	**67**	**60**	**51**	**41**	**29**	**15**	**0**
90	30		**89**	**87**	**83**	**77**	**70**	**61**	**51**	**39**	**25**	**10**
100	20		**99**	**97**	**93**	**87**	**80**	**71**	**61**	**49**	**35**	**20**
110	10		**109**	**107**	**103**	**97**	**90**	**81**	**71**	**59**	**45**	**30**
120	0		**119**	**117**	**113**	**107**	**100**	**91**	**81**	**69**	**55**	**40**

Type A's Payoff if the Project **Fails**

Debt Forgiven	Debt Remaining	Type A's Effort Cost (francs)										
		0	1	3	7	13	20	29	39	51	65	80
0	120	**0**	**-1**	**-3**	**-7**	**-13**	**-20**	**-29**	**-39**	**-51**	**-65**	*cannot happen*
10	110	**0**	**-1**	**-3**	**-7**	**-13**	**-20**	**-29**	**-39**	**-51**	**-65**	
20	100	**0**	**-1**	**-3**	**-7**	**-13**	**-20**	**-29**	**-39**	**-51**	**-65**	
30	90	**0**	**-1**	**-3**	**-7**	**-13**	**-20**	**-29**	**-39**	**-51**	**-65**	
40	80	**0**	**-1**	**-3**	**-7**	**-13**	**-20**	**-29**	**-39**	**-51**	**-65**	
50	70	**0**	**-1**	**-3**	**-7**	**-13**	**-20**	**-29**	**-39**	**-51**	**-65**	
60	60	**0**	**-1**	**-3**	**-7**	**-13**	**-20**	**-29**	**-39**	**-51**	**-65**	
70	50	**0**	**-1**	**-3**	**-7**	**-13**	**-20**	**-29**	**-39**	**-51**	**-65**	
80	40	**0**	**-1**	**-3**	**-7**	**-13**	**-20**	**-29**	**-39**	**-51**	**-65**	
90	30	**10**	**9**	**7**	**3**	**-3**	**-10**	**-19**	**-29**	**-41**	**-55**	
100	20	**20**	**19**	**17**	**13**	**7**	**0**	**-9**	**-19**	**-31**	**-45**	
110	10	**30**	**29**	**27**	**23**	**17**	**10**	**1**	**-9**	**-21**	**-35**	
120	0	**40**	**39**	**37**	**33**	**27**	**20**	**11**	**1**	**-11**	**-25**	

Type B's Payoff if the Project **Succeeds**

Debt Forgiven	Debt Remaining	Type A's Effort Cost (francs)										
		0	1	3	7	13	20	29	39	51	65	80
0	120	*cannot happen*	**120**	**120**	**120**	**120**	**120**	**120**	**120**	**120**	**120**	**120**
10	110		**110**	**110**	**110**	**110**	**110**	**110**	**110**	**110**	**110**	**110**
20	100		**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**
30	90		**90**	**90**	**90**	**90**	**90**	**90**	**90**	**90**	**90**	**90**
40	80		**80**	**80**	**80**	**80**	**80**	**80**	**80**	**80**	**80**	**80**
50	70		**70**	**70**	**70**	**70**	**70**	**70**	**70**	**70**	**70**	**70**
60	60		**60**	**60**	**60**	**60**	**60**	**60**	**60**	**60**	**60**	**60**
70	50		**50**	**50**	**50**	**50**	**50**	**50**	**50**	**50**	**50**	**50**
80	40		**40**	**40**	**40**	**40**	**40**	**40**	**40**	**40**	**40**	**40**
90	30		**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
100	20		**20**	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**20**
110	10		**10**	**10**	**10**	**10**	**10**	**10**	**10**	**10**	**10**	**10**
120	0		**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

Type B's Payoff if the Project **Fails**

Debt Forgiven	Debt Remaining	Type A's Effort Cost (francs)										
		0	1	3	7	13	20	29	39	51	65	80
0	120	**40**	**40**	**40**	**40**	**40**	**40**	**40**	**40**	**40**	**40**	*cannot happen*
10	110	**40**	**40**	**40**	**40**	**40**	**40**	**40**	**40**	**40**	**40**	
20	100	**40**	**40**	**40**	**40**	**40**	**40**	**40**	**40**	**40**	**40**	
30	90	**40**	**40**	**40**	**40**	**40**	**40**	**40**	**40**	**40**	**40**	
40	80	**40**	**40**	**40**	**40**	**40**	**40**	**40**	**40**	**40**	**40**	
50	70	**40**	**40**	**40**	**40**	**40**	**40**	**40**	**40**	**40**	**40**	
60	60	**40**	**40**	**40**	**40**	**40**	**40**	**40**	**40**	**40**	**40**	
70	50	**40**	**40**	**40**	**40**	**40**	**40**	**40**	**40**	**40**	**40**	
80	40	**40**	**40**	**40**	**40**	**40**	**40**	**40**	**40**	**40**	**40**	
90	30	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**	
100	20	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**20**	
110	10	**10**	**10**	**10**	**10**	**10**	**10**	**10**	**10**	**10**	**10**	
120	0	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	

Instructions for Experiment (Buyback Treatment)

March 2007

1. General Instructions

This is an experiment studying decision-making. The instructions are simple and if you follow them carefully and make good decisions, you might earn a considerable amount of money which will be paid to you in cash at the end of the experiment. It is therefore very important that you read these instructions with care.

It is prohibited to communicate with other participants during the experiment. Should you have any questions please ask us. If you violate this rule, we shall have to exclude you from the experiment and from all payments.

During the experiment your earnings will be calculated in francs. At the end of the experiment the total amount of francs you have earned will be converted to NZ dollars at the following rate:

30 francs = $1

There are two types of participants in the experiment, Type A and Type B. You have been randomly assigned a type, as indicated on top of this instruction sheet. In each period, you will be paired with another participant whom we will call your counterpart. Each pair of two consists of a Type A and a Type B participant. In other words, if you are Type A, your counterpart will be Type B, and vice versa.

The experiment is divided into 20 periods. The experiment is designed so that you will be randomly matched with a counterpart each period, but never with the same counterpart two periods in a row.

2. Detailed Instructions

2.1 Endowment

At the beginning of each period, a Type A participant is endowed with 120 francs of debt owed to Type B and 40 francs of cash balance. A Type B participant, other than the 120 francs loaned to Type A, is endowed with nothing else.

Notice that it is impossible for Type A to pay off all his debt at the beginning of any given period. Nonetheless, Type A will be given an opportunity to undertake a project that, when succeed, will generate extra 80 francs at the end of the period and Type A can thus pay off his debt. There is a chance that the project will fail and, as a result, 80 francs will not be realized.

To increase the chance that the project will succeed, Type A will need to make an effort which comes with a monetary cost. The following table provides the relationship between the effort cost (in francs) and the probability that the project will succeed (the rate of success). For example, if Type A decides not to make any effort and thus incur no cost, the probability that the project will succeed is 0%. On the other hand, if Type A is willing to incur 80 francs of effort cost, the probability that the project will succeed becomes 100%. The rate of success, as indicated by the table, increases with the effort cost. How the effort cost affects Type A's payoff will be explained in Section 3.

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

2.2 Decisions

In each period, the game is divided into two stages in which the two counterparts take turns to make their decisions:

Stage 1: In Stage 1, Type B, as the creditor, has an opportunity to sell some or all of the 120 francs debt back to his Type A counterpart. More specifically, for **each** franc of debt, Type B must decide a price that he is willing to sell that one franc of debt back to Type A. The possible price, as will be shown on Type B's computer monitor, ranges from 0 to 1 with 0.1 franc increments. A price of 1.0 means that, for each one franc of debt, Type A will pay exactly 1 franc to buy it back. A price that is between 0 and 1 means that Type A can buy back some or all of his debt at a discount. Finally, a price of 0 means that Type A will have no responsibility to pay off his debt at all.

Given the price offered by Type B, the computer system will automatically use Type A's initial cash balance (40 francs) to buy back as much debt as possible for Type A.

Example 1: If Type B decides to sell **each** franc of debt at a price of 0.8, the computer system will be able to buy back 50 francs of debt using Type A's initial cash balance of 40 francs, i.e. 50 * 0.8 = 40. In this case, the remaining cash balance for Type A is 40 (*initial endowment*) – *50 * 0.8* = 40 – 40 = 0 and his remaining debt is 120 (*initial debt*) – 50 (*amount of debt bought back*) = 70 francs. As for Type B, his earnings from selling the debt are 40 francs.

Example 2: If Type B decides to sell **each** franc of debt at a price of 0.2, the computer system will be able to buy back all of the debt (*120 francs*). More specifically, it will cost Type A 24 francs to buy back the entire 120 francs of debt at the price of 0.2 francs per franc of debt, i.e. 120 * 0.2 = 24. Therefore, the remaining cash balance for Type A is 40 (*initial endowment*) – 120 * 0.2 (*endowment used to buy back debt*) = 40 – 24 = 16 and his remaining debt is 120 – 120 = 0. As for Type B, his earnings from selling the debt are 24 francs.

Note that since the computer system will try to buy back Type A's debt as much as possible, at the end of Stage 1, Type A should either has 0 cash balance and some debt remaining (as in example 1), or 0 debt and some cash balance remaining (as in example 2).

Stage 2: After the computer system buys back some or all of his debt, Type A decides how much effort cost he is willing to incur in order to complete the project, i.e. earn an additional 80 francs from a successfully completed project.

After Stage 2, the computer system will decide if the project succeeds or not given the project's success rate determined by Type A's effort cost.

3. Type A's Period Payoff

Type A's period payoff depends on four factors: (1) his effort cost, (2) if the project succeeds, (3) how much cash is remaining, and (4) how much debt is remaining. Note that the last two factors are determined by the price that Type B is willing to sell **each** franc of debt.

- **If the project succeeds:**

  The extra income of 80 francs will be realized if the project succeeds. Under such a circumstance, Type A's period payoff equals the remaining cash balance (*the portion of the 40 franc endowment, if any, not used to buy back debt*) + extra income generated by the successful project (*80 francs*) – remaining debt – effort cost. That is,

  Type A's payoff if the project succeeds
  = remaining cash balance + 80 – remaining debt – effort cost

- **If the project fails:**

  The extra income of 80 francs will not be realized if the project fails. Under such a circumstance, the maximum amount of remaining debt Type A can pay off is his remaining cash balance (*the portion of the 40 franc endowment, if any, not used to buy back debt*). Therefore,

  Type A's payoff if the project fails

  = remaining cash balance – effort cost

Example 3: Suppose that Type B has decided to sell **each** franc of debt at a price of 0.8. From example 1, we know Type A's remaining cash balance is 0 and his remaining debt is 70 francs. Suppose also that Type A decides to incur 39 francs to increase the project's success rate to 70%. If the project succeeds, Type A's payoff is 0 (*remaining cash balance*) + 80 (*return from the project*) – 70 (*remaining debt*) – 39 (*effort cost*) = –29 francs. If the project fails, Type A's payoff becomes 0 (*remaining cash balance*) – (*effort cost*) 39 = –39 francs. Note that since the project's success rate is 70%, it is more likely for Type A to lose 29 francs than to lose 39.

Example 4: Suppose that Type B has decided to sell **each** franc of debt at a price of 0.2. From example 2, we know Type A's remaining cash balance is 16 and his remaining debt is 0. Suppose also that Type A decides to incur 39 francs to increase the project's success rate to 70%. If the project succeeds, Type A's payoff is 16 (*remaining cash balance*) + 80 (*return from the project*) – 0 (*remaining debt*) – 39 (*effort cost*) = 57 francs. If the project fails, Type A's payoff becomes 16 (*remaining cash balance*) – 39 (*effort cost*) = –23 francs. Note that since the project's success rate is 70%, it is more likely for Type A to earn 57 francs than to lose 23.

You may use the **Payoff Sheet** to help you find out Type A's period payoffs. The small table at the top right corner of the sheet is used to remind participants the relationship between Type A's effort cost and the project's success rate. The two big payoff tables on the top are Type A's payoff tables. The table on the left is for the case when the project succeeds, and the table on the right is for the case when the project fails. The first row labeled *Type A's Effort Cost* lists all the possible effort costs that Type A can incur. The first column labeled *Price* lists all the possible prices that Type B can sell each of **each** franc of debt. The second column labeled Cash Remaining equals the initial cash balance (*40 francs*) – the amount of the debt being bought back * the price for **each** franc of debt. The third column labeled Debt Remaining equals 120 – the

amount of the debt being bought back. The numbers in bold are the possible payoffs for Type A, which is calculated based on the above formulas.

4. Type B's Period Payoff

Type B's period payoff depends on only three factors: (1) if Type A's project succeeds, (2) how much Type A's cash is remaining, and (3) how much Type A's debt is remaining. Note that the last two factors are determined by the price that Type B is willing to sell **each** franc debt.

- **If the project succeeds:**

  The extra income of 80 francs will be realized if the project succeeds. Under such a circumstance, Type A must pay off all his remaining debt, and thus Type B's period payoff equals his earnings from selling some or all of the debt at the end of Stage 1 plus Type A's remaining debt.

  Type B's payoff if the project succeeds
  = earnings from selling debt in Stage 1 + Type A's remaining debt

- **If the project fails:**

  The extra income of 80 francs will not be realized if the project fails. Under such a circumstance, Type B's period payoff is simply his earnings from selling some or all of the debt at the end of Stage 1.

  Type B's payoff if the project fails

  = earnings from selling debt in Stage 1

Example 5: Suppose that for **each** franc of debt, Type B has decided to sell at a price of 0.8. From example 1, we know that Type B's earnings from selling the debt are 40 francs, Type A's remaining cash balance is 0 and his remaining debt is 70 francs. Suppose also that Type A has incurred 39 francs to increase the project's success rate to 70%. If the project succeeds, Type B's payoff is 40 (*return from selling debt*) + 70 (*remaining debt*) = 110 francs. If the project fails, Type B's payoff is 40 francs (*return from selling debt*). Note that since the project's success rate is 70%, it is more likely for Type B to make 110 than to make 40.

Example 6: Suppose that for **each** franc of debt, Type B has decided to sell at a price of 0.2. From example 2, we know that Type B's earnings from selling the debt are 24 francs, Type A's remaining cash balance is 16 and his remaining debt is 0. Suppose also that Type A has incurred 39 francs to increase the project's success rate to 70%. If the project succeeds, Type B's payoff is 24 (*return from selling debt*) + 0 (*remaining debt*) = 24 francs. If the project fails, Type B's payoff is also 24 francs (*return from selling debt*).

You may use the **Payoff Sheet** to help you find out Type B's period payoffs. The two big payoff tables at the bottom of the sheet are Type B's payoff tables. The table on the left is for the case when the project succeeds, and the table on the right is for the case when the project fails. The first row labeled *Type A's Effort Cost* lists all the possible effort costs that Type A can incur. The first column labeled *Price* lists all the possible prices that Type B can sell **each** franc of debt. The second column labeled Cash Remaining equals the initial cash balance (*40 francs*) – the amount of the debt being bought back * the price for **each** franc of debt. The third column labeled Debt Remaining equals 120 – the amount of the debt being bought back. The numbers in bold are the possible payoffs for Type B, which is calculated based on the above formulas.

5. Period Earning Sheet

At the end of each period, record your period earnings on your **Period Earnings Sheet**. The first column of the Period Earnings Sheet indicates the current period. Record the price at which Type B sold his debt claims in column 2 labeled *Price of **Each** franc of Debt*. Record the effort cost Type A chose to incur in column 3 labeled *A's Effort Cost*. Record if the project succeeded or not in column 4 labeled *Succeed*. Record your period payoff in column 5 labeled *Your Period Payoff*.

At the beginning of the experiment, you will be given an initial endowment of 150 francs. Your total earnings for the experiment are your initial endowment (*150 francs*) plus the total period payoffs from periods 1 to 20. If your earnings from periods 1 – 20 payoffs are negative, this negative amount will be subtracted from your initial endowment.

There will be a practice period, 0, which will not count toward your final earnings.

6. Quiz

To check your understanding of the experiment, please answer the following questions.

1. Suppose that Type B is willing to sell **each** franc of debt at a price of 0.7. Suppose also that Type A decides to incur 65 francs of effort cost.

   (i) What's the probability that the project will succeed (success rate)? _____
   (j) How much is Type A's remaining cash? _____ francs
   (k) How much is Type A's remaining debt? _____ francs
   (l) What is Type A's payoff if the project succeeds? _____ francs
   (m) What is Type A's payoff if the project fails? _____ francs
   (n) Which of the above payoffs is more likely to happen to A? _____ francs
   (o) What is Type B's payoff if the project succeeds? _____ francs
   (p) What is Type B's payoff if the project fails? _____ francs
   (q) Which of the above payoff is more likely to happen to B? _____

2. Suppose that Type B is willing to sell **each** franc of debt at a price of 0.3. Suppose also that Type A decides to incur 3 francs of effort cost.

   (i) What's the probability that the project will succeed (success rate)? _____
   (j) How much is Type A's remaining cash? _____ francs
   (k) How much is Type A's remaining debt? _____ francs
   (l) What is Type A's payoff if the project succeeds? _____ francs
   (m) What is Type A's payoff if the project fails? _____ francs
   (n) Which of the above payoffs is more likely to happen to A? _____ francs
   (o) What is Type B's payoff if the project succeeds? _____ francs
   (p) What is Type B's payoff if the project fails? _____ francs
   (q) Which of the above payoff is more likely to happen to B? _____

ID #: _____ Type: _____

PERIOD EARNINGS SHEET

(1) Current Period	(2) Price of Each franc of Debt	(3) A's Effort Cost	(4) Succeed (Yes/No)	(5) Your Period Payoff
0	_____	_____	_____	_____
1	_____	_____	_____	_____
2	_____	_____	_____	_____
3	_____	_____	_____	_____
4	_____	_____	_____	_____
5	_____	_____	_____	_____
6	_____	_____	_____	_____
7	_____	_____	_____	_____
8	_____	_____	_____	_____
9	_____	_____	_____	_____
10	_____	_____	_____	_____
11	_____	_____	_____	_____
12	_____	_____	_____	_____
13	_____	_____	_____	_____
14	_____	_____	_____	_____
15	_____	_____	_____	_____
16	_____	_____	_____	_____
17	_____	_____	_____	_____
18	_____	_____	_____	_____
19	_____	_____	_____	_____
20	_____	_____	_____	_____

PAYOFF SHEET

Type A's Effort Cost (francs)	0	1	3	7	13	20	29	39	51	65	80
Rate of Success	**0%**	**10%**	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**100%**

Type A's Payoff if Project **Succeeds**

Price	Cash Remaining	Debt Remaining	Type A's Effort Cost (francs)										
			0	1	3	7	13	20	29	39	51	65	80
1.0	0	80	*cannot happen*	**-1**	**-3**	**-7**	**-13**	**-20**	**-29**	**-39**	**-51**	**-65**	**-80**
0.9	0	76		**3**	**1**	**-3**	**-9**	**-16**	**-25**	**-35**	**-47**	**-61**	**-76**
0.8	0	70		**9**	**7**	**3**	**-3**	**-10**	**-19**	**-29**	**-41**	**-55**	**-70**
0.7	0	63		**16**	**14**	**10**	**4**	**-3**	**-12**	**-22**	**-34**	**-48**	**-63**
0.6	0	53		**26**	**24**	**20**	**14**	**7**	**-2**	**-12**	**-24**	**-38**	**-53**
0.5	0	40		**39**	**37**	**33**	**27**	**20**	**11**	**1**	**-11**	**-25**	**-40**
0.4	0	20		**59**	**57**	**53**	**47**	**40**	**31**	**21**	**9**	**-5**	**-20**
0.3	4	0		**83**	**81**	**77**	**71**	**64**	**55**	**45**	**33**	**19**	**4**
0.2	16	0		**95**	**93**	**89**	**83**	**76**	**67**	**57**	**45**	**31**	**16**
0.1	28	0		**107**	**105**	**101**	**95**	**88**	**79**	**69**	**57**	**43**	**28**
0.0	40	0		**119**	**117**	**113**	**107**	**100**	**91**	**81**	**69**	**55**	**40**

Type A's Payoff if Project **Fails**

Price	Cash Remaining	Debt Remaining	Type A's Effort Cost (francs)										
			0	1	3	7	13	20	29	39	51	65	80
1.0	0	80	**0**	**-1**	**-3**	**-7**	**-13**	**-20**	**-29**	**-39**	**-51**	**-65**	*cannot happen*
0.9	0	76	**0**	**-1**	**-3**	**-7**	**-13**	**-20**	**-29**	**-39**	**-51**	**-65**	
0.8	0	70	**0**	**-1**	**-3**	**-7**	**-13**	**-20**	**-29**	**-39**	**-51**	**-65**	
0.7	0	63	**0**	**-1**	**-3**	**-7**	**-13**	**-20**	**-29**	**-39**	**-51**	**-65**	
0.6	0	53	**0**	**-1**	**-3**	**-7**	**-13**	**-20**	**-29**	**-39**	**-51**	**-65**	
0.5	0	40	**0**	**-1**	**-3**	**-7**	**-13**	**-20**	**-29**	**-39**	**-51**	**-65**	
0.4	0	20	**0**	**-1**	**-3**	**-7**	**-13**	**-20**	**-29**	**-39**	**-51**	**-65**	
0.3	4	0	**4**	**3**	**1**	**-3**	**-9**	**-16**	**-25**	**-35**	**-47**	**-61**	
0.2	16	0	**16**	**15**	**13**	**9**	**3**	**-4**	**-13**	**-23**	**-35**	**-49**	
0.1	28	0	**28**	**27**	**25**	**21**	**15**	**8**	**-1**	**-11**	**-23**	**-37**	
0.0	40	0	**40**	**39**	**37**	**33**	**27**	**20**	**11**	**1**	**-11**	**-25**	

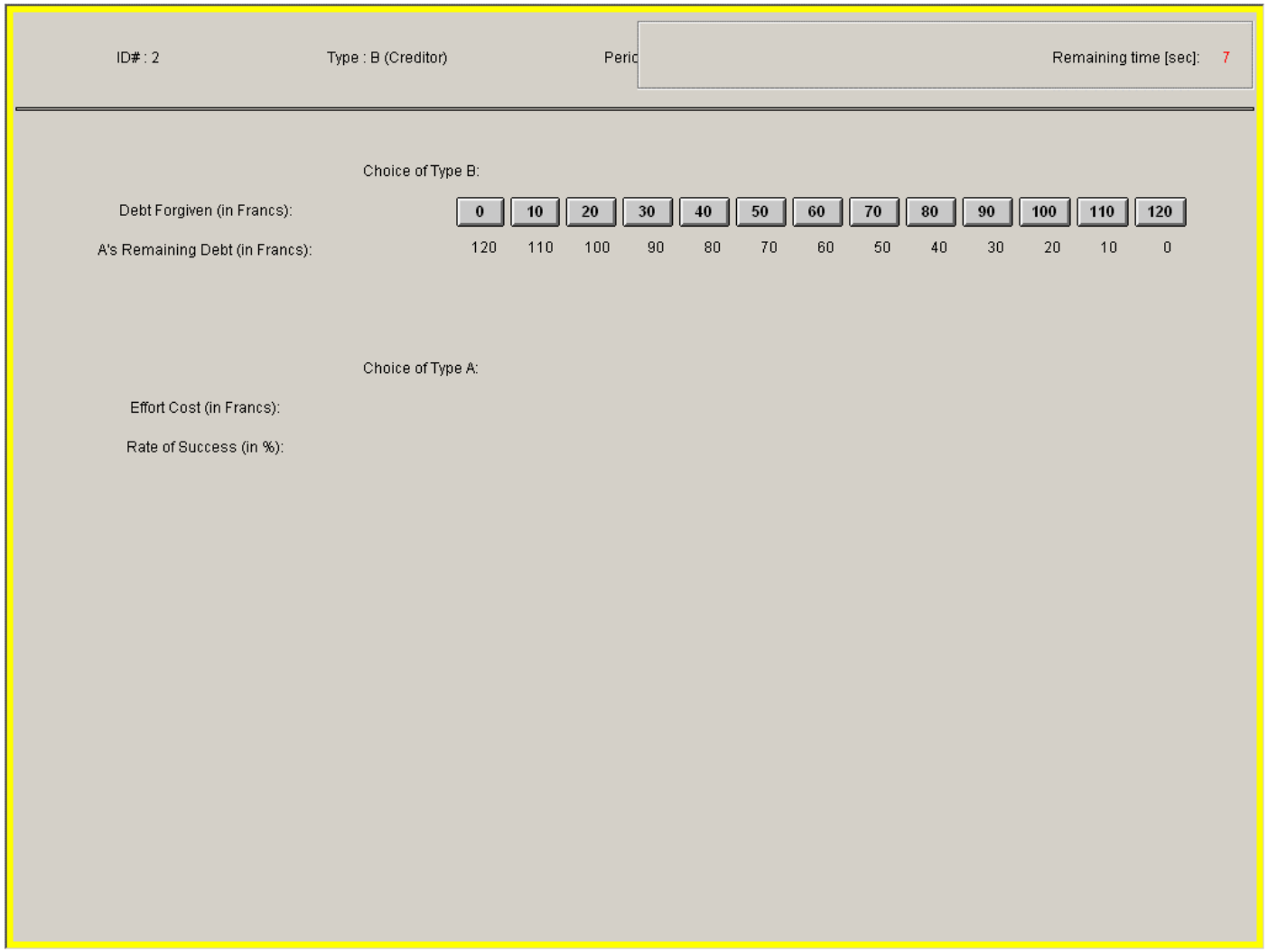
Type B's Payoff if Project **Succeeds**

Price	Cash Remaining	Debt Remaining	Type A's Effort Cost (francs)										
			0	1	3	7	13	20	29	39	51	65	80
1.0	0	80	*cannot happen*	**120**	**120**	**120**	**120**	**120**	**120**	**120**	**120**	**120**	**120**
0.9	0	76		**116**	**116**	**116**	**116**	**116**	**116**	**116**	**116**	**116**	**116**
0.8	0	70		**110**	**110**	**110**	**110**	**110**	**110**	**110**	**110**	**110**	**110**
0.7	0	63		**103**	**103**	**103**	**103**	**103**	**103**	**103**	**103**	**103**	**103**
0.6	0	53		**93**	**93**	**93**	**93**	**93**	**93**	**93**	**93**	**93**	**93**
0.5	0	40		**80**	**80**	**80**	**80**	**80**	**80**	**80**	**80**	**80**	**80**
0.4	0	20		**60**	**60**	**60**	**60**	**60**	**60**	**60**	**60**	**60**	**60**
0.3	4	0		**36**	**36**	**36**	**36**	**36**	**36**	**36**	**36**	**36**	**36**
0.2	16	0		**24**	**24**	**24**	**24**	**24**	**24**	**24**	**24**	**24**	**24**
0.1	28	0		**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**
0.0	40	0		**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

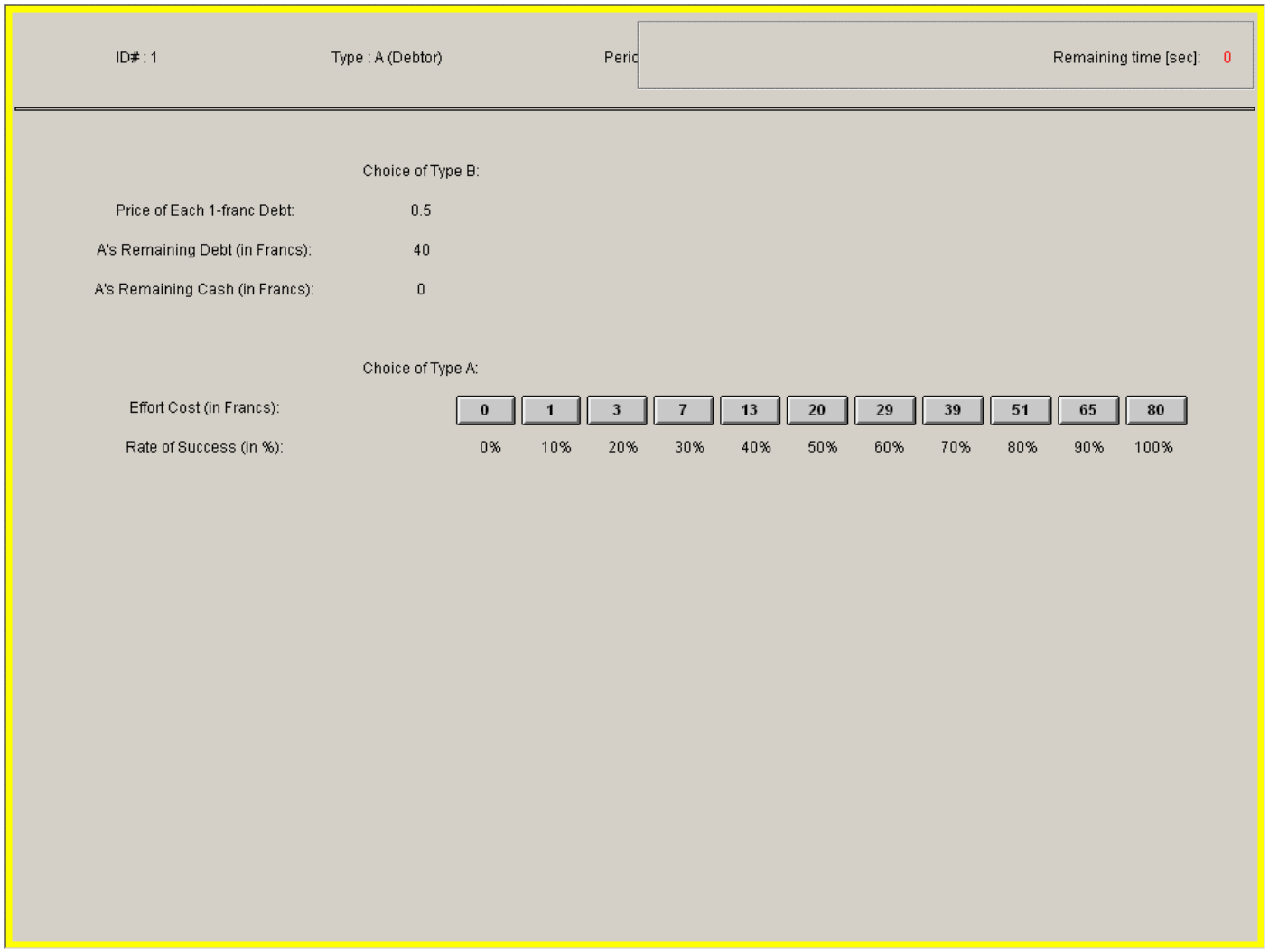
Type B's Payoff if Project **Fails**

Price	Cash Remaining	Debt Remaining	Type A's Effort Cost (francs)										
			0	1	3	7	13	20	29	39	51	65	80
1.0	0	80	**40**	**40**	**40**	**40**	**40**	**40**	**40**	**40**	**40**	**40**	*cannot happen*
0.9	0	76	**40**	**40**	**40**	**40**	**40**	**40**	**40**	**40**	**40**	**40**	
0.8	0	70	**40**	**40**	**40**	**40**	**40**	**40**	**40**	**40**	**40**	**40**	
0.7	0	63	**40**	**40**	**40**	**40**	**40**	**40**	**40**	**40**	**40**	**40**	
0.6	0	53	**40**	**40**	**40**	**40**	**40**	**40**	**40**	**40**	**40**	**40**	
0.5	0	40	**40**	**40**	**40**	**40**	**40**	**40**	**40**	**40**	**40**	**40**	
0.4	0	20	**40**	**40**	**40**	**40**	**40**	**40**	**40**	**40**	**40**	**40**	
0.3	4	0	**36**	**36**	**36**	**36**	**36**	**36**	**36**	**36**	**36**	**36**	
0.2	16	0	**24**	**24**	**24**	**24**	**24**	**24**	**24**	**24**	**24**	**24**	
0.1	28	0	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	
0.0	40	0	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	

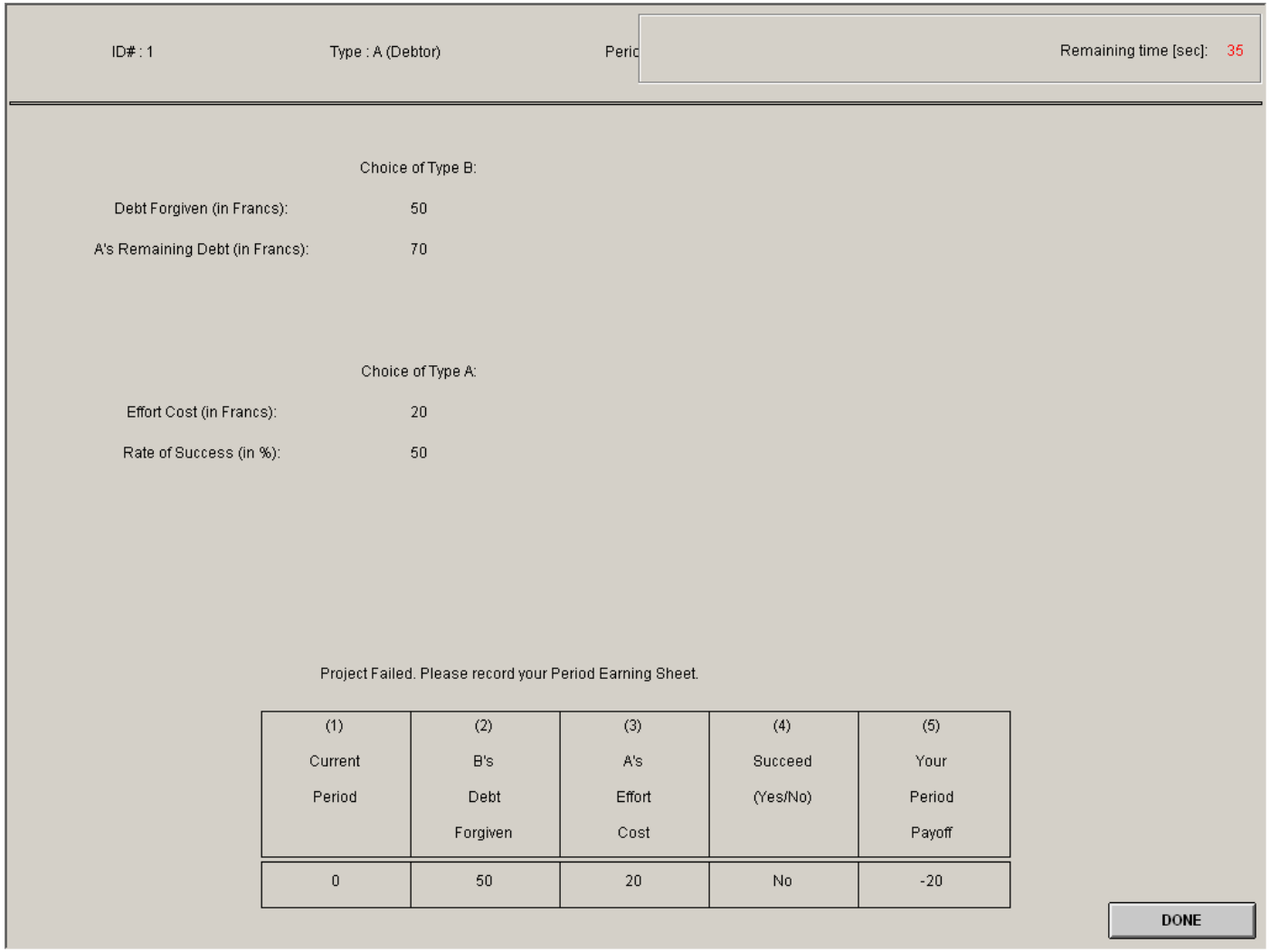
Forgive Treatment: Creditor Decision Screen



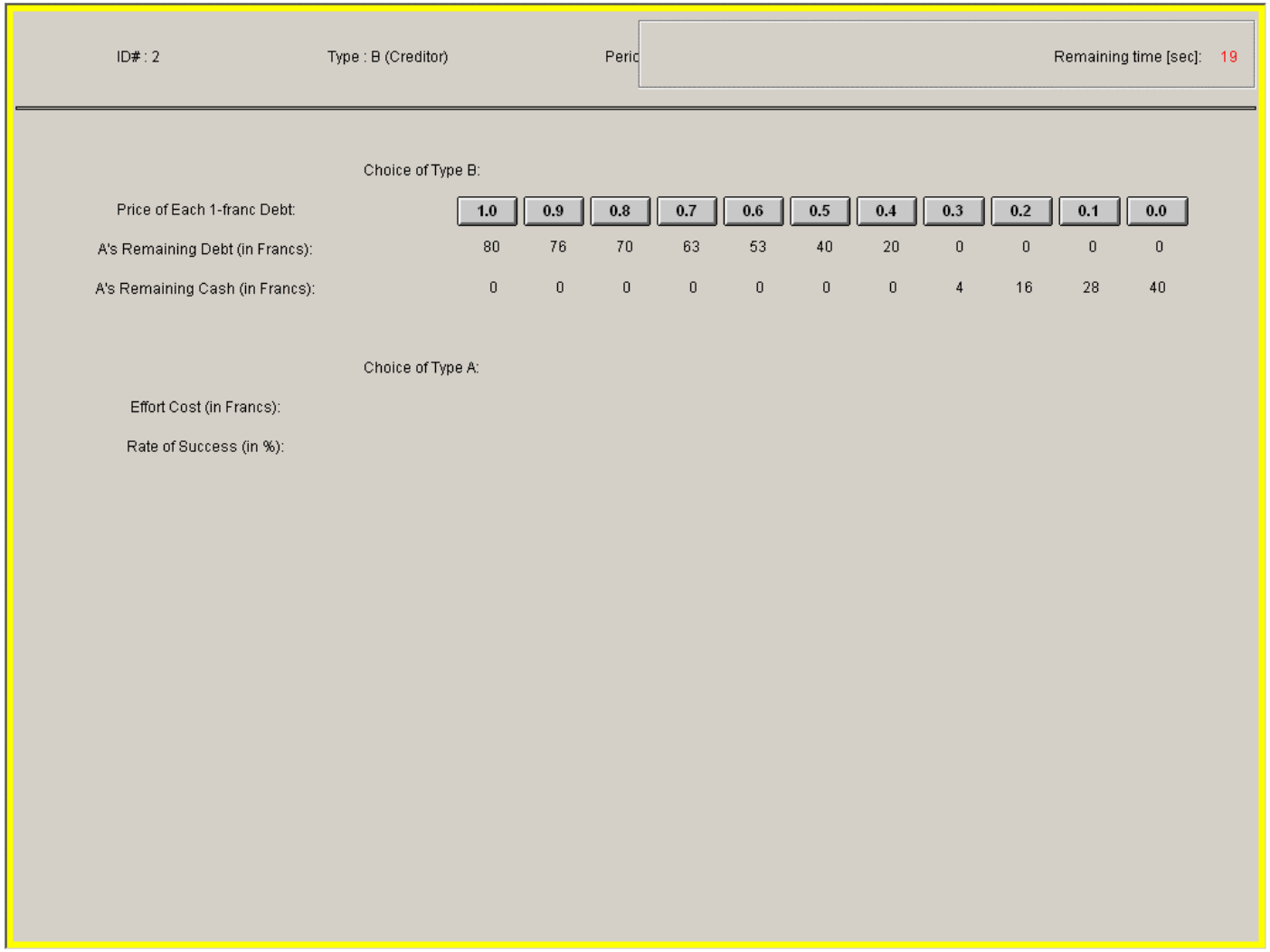
Forgive Treatment: Debtor Decision Screen



Forgive Treatment: Summary Screen

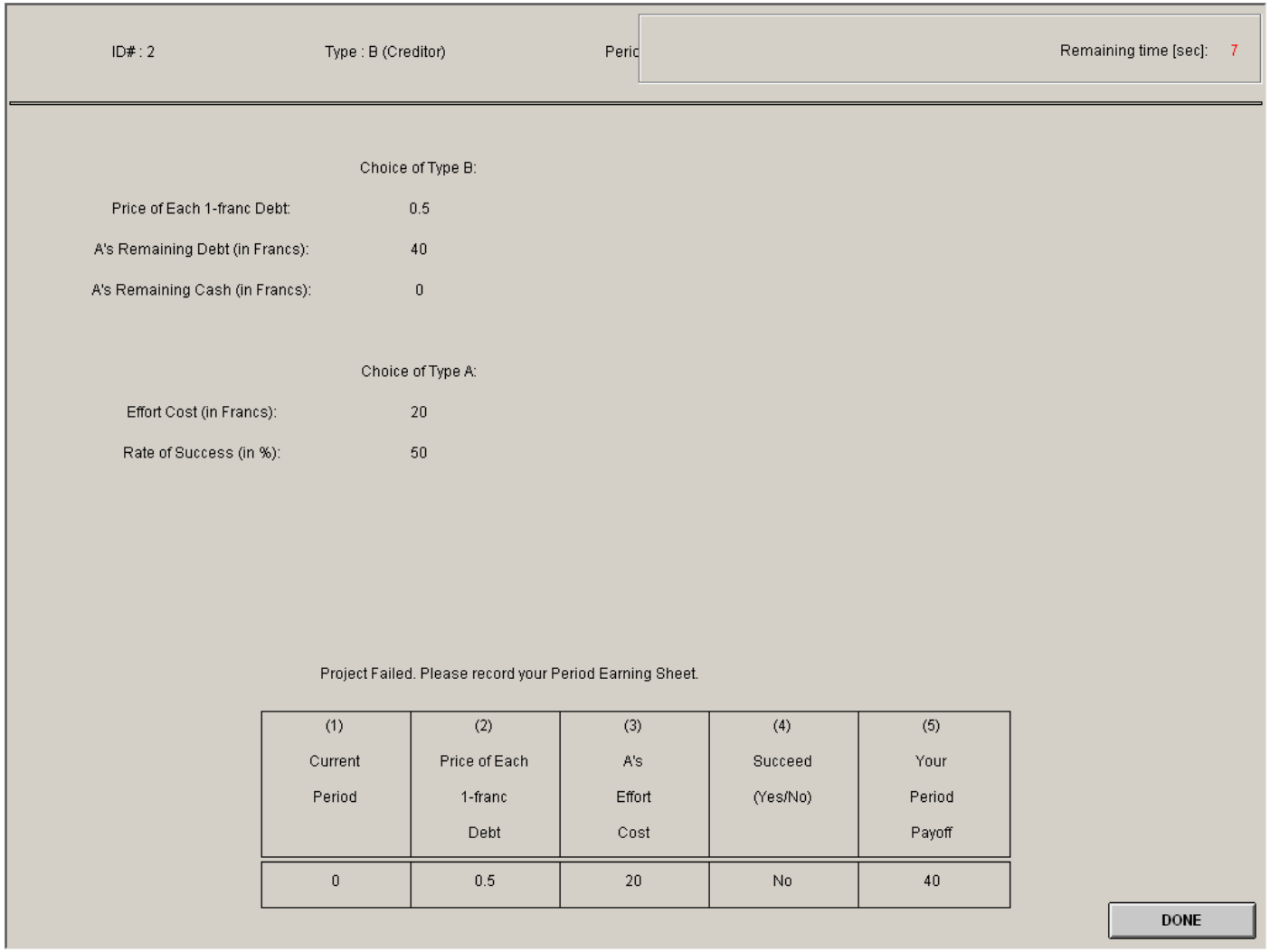


Buyback Treatment: Creditor Decision Screen



Buyback Treatment: Debtor Decision Screen

Buyback Treatment: Summary Screen



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