

Should I default on my mortgage even if I can pay? Experimental Evidence *

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PRELIMINARY VERSION

Abstract

We study strategic default in the laboratory, i.e., in a controlled experiment. Subjects are initially endowed with a house and a mortgage (we use neutral wording in the experiment), and must decide at each period in which their mortgage is alive among three options: making the mortgage payment, selling the house, or walking away from their house and defaulting on their mortgage. In the last two cases they will have to rent for the rest of their life. At each point in time, we can observe whether defaulters can afford to make the mortgage payment, and thus, directly compute the number of strategic defaulters. Subjects default in the right periods and quite fast learn what they should consume. However, they default less than optimal (and social norm seems to be important) and they consume less than optimal in the first periods of life: they are “cautious” when indebted. Both introducing a 50% probability of recourse and a Responsible Homeowner Reward are quite effective in discouraging default.

KEYWORDS: Strategic Mortgage Default, Negative Equity, Household Indebtedness, Housing, Laboratory Experiment

JEL CODES: E70, E21, R21, G41, G11.

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1. Introduction

After years of mortgage credit expansion and increasing house values, the 2007-2008 bust in house prices left millions of people with negative home equity, that is, with an outstanding mortgage debt exceeding the market value of their house. This is true especially in those countries that experienced a stronger housing boom. In the U.S., an estimated 10.7 million mortgages - 22.1% of all mortgaged properties - were “underwater” at the end of the third quarter of 2011.¹ In Europe, Ireland and Spain were the worst hit by the housing market crisis: 31% of Irish properties with a mortgage were in negative equity by the end of 2010 (Kennedy and McIndoe Calder, 2012), while one out of ten Spanish mortgages was estimated to be in this situation at the end of 2013 (Centre for Economics and Business Research, 2013). Not surprisingly, mortgage default rates rose during the crisis in these countries. In the U.S., mortgage default peaked in the first quarter of 2010, when the foreclosure rate was 4.6% (the corresponding figure in 2006, before the crisis, was 0.99%), and the delinquency rate was above 10% (4.7% in 2006).² In 2011, 7.2% of Irish residential mortgages were in arrears for 90 days or more (Lydon and McCarthy, 2011), while in Spain the delinquency rate on housing credit reached its highest value of 6.3% in 2014 (Spanish Mortgage Association, 2017). These rates correspond to more than a six-fold increase with respect to pre-crisis’ figures. Due to the economically harsh times, many of the homeowners that defaulted on their mortgage simply could not afford to make the payments. Some others, though, are likely to have decided that it did not make any financial sense to continue payments, particularly if the institutional framework allowed them to start (almost) afresh. Borrowers who stop servicing their mortgage debt despite their ability to pay are called “strategic”, and represent

¹According to a report by CoreLogic (2011), the U.S. states with the highest number of underwater mortgaged properties were Nevada (58% of all residential properties with a mortgage were in negative equity), Arizona (47%) and Florida (44%).

²Data are from the National Delinquency Surveys of the Mortgage Bankers Association. The mortgage delinquency rate is computed as the number of homes that fell behind with mortgage payments (but not yet in foreclosure), divided by the total number of outstanding home loans. The foreclosure rate takes into account only homes that are going through a foreclosure process.

a potentially serious problem to the economy as a whole, given that strategic default could be contagious: people walking away from their house in a certain area could further depress house prices and decrease the “stigma” attached to default in that area, thus leading to more people walking away, in what would become a vicious circle (Bradley *et al.*, 2015, and Goodstein *et al.*, 2017).

Identifying strategic default is very difficult: it requires detailed data on the borrowers’ income and balance sheet, to determine their ability to pay. Some studies use loan-level data and define as strategic defaulters those individuals who didn’t make any mortgage payments for 180 days or more, while being current on all their other debts (credit cards, car loans, etc.). Using this measure, Experian-Oliver Wyman (2011) reports that in 2008 about 20% of total U.S. defaults were strategic, percentage only slightly decreased at 17% in 2010. Guiso, Sapienza and Zingales (2013) use questionnaire data to obtain an estimate of the percentage of total defaults that are strategic. Combining the respondents’ answers to the questions “How many people do you know who have defaulted on their house mortgage?” and “Of the people you know who have defaulted on their mortgage, how many do you think walked away even if they could afford to pay the monthly mortgage?”, these authors obtain an estimate of strategic default that ranges from 26% in 2009 to 35% in 2010. The most complete information so far on ability to pay is probably given by the data used in Gerardi *et al.* (2018). Their data comes from the Panel Study of Income Dynamics (PSID) surveys between 2009 and 2013, and provides information on mortgagor’ balance sheets, income, consumption and default behavior. The authors identify strategic defaulters as those households in default that have the ability to meet their mortgage payments without having to reduce their level of consumption. According to this definition, 38% of defaults in their sample are strategic.³ On the other hand, Gerardi *et al.* (2018) as well as Bhutta *et al.* (2017) and White (2010) underline how the majority of (U.S.) homeowners continue to make their mortgage payments despite being deeply underwater.

³Using an alternative definition, however, 71% of defaulters would be able to reach a subsistence level of consumption if they met the mortgage payments. For Loan To Value (LTV) ratios higher than 90, estimates of strategic default range from 41% to 76% of total default (Gerardi *et al.*, 2018).

That is, the repayment decision must depend on reasons other than the purely rational motive driven by equity concerns. The sense of guilt or shame of foreclosure, the fear of the perceived consequences of default, a wrong subjective evaluation of house equity, optimistic expectations on future house prices, or the special attachment to one's own home can play a very important role.

There are two problems with the above mentioned studies. First, information on social norms, individual moral concerns, perceived future risks or costs of default is missing.⁴ Second, the observed data do not allow for policy analysis: how would strategic default behavior change under a stricter recourse policy? Or under different mortgage conditions?

We intend to alleviate these problems by studying strategic default in the laboratory, that is, in an environment in which we control for default costs, agents' risk and mortgage conditions. Moreover, we create a situation in which all default is strategic. In our economic experiment, we endow individuals with a house and a mortgage (in a neutral framework), and have them choose at each experimental period for the whole duration of the mortgage life among three options: making the mortgage payment, selling the house and prepaying the mortgage, or walking away from their house and defaulting on their mortgage. In the last two cases they have to rent for the rest of their life. Subjects face shocks to their employment status and to the market value of houses with a known probability, and have the possibility of accumulating liquid wealth. At any point in time, we can observe whether individuals can afford to make their mortgage payment and thus, directly compute the number of strategic defaulters. We also test subjects' rationality, collect information on their perception of future risk and ask them questions on social and moral aspects of default.

Our main goals are the following:

1) to compare subjects' behavior observed in the experiment with the rational choices pre-

⁴Guiso *et al.* (2013) ask some questions on social and moral concerns in their survey. However, the default decision is also the answer to a question ("If the value of your mortgage exceeded the value of your house by 50K [100K/150K] would you walk away from your house (i.e., default on your mortgage) even if you could afford to pay your monthly mortgage?"). Respondents' declaration could well differ from their real actions.

dicted by a corresponding intertemporal model of default decisions. Given each combination of initial state variables faced by the experimental subject, we can compute the theoretically optimal choices and compare them to the observed actions.

2) to measure to what extent individuals strategically default. We on purpose parameterize the model (and the experiment) so that it generates some situations in which it is optimal to strategically default and we observe individuals' behavior.

3) to test the efficacy of economic incentives aimed at decreasing the amount of strategic defaults. We do this in two treatments. In Treatment 1, we allow for the possibility (with a positive probability) that the defaulter must repay the part of the mortgage debt not covered by the collateral. In the baseline treatment the defaulter is just allowed to walk away from the mortgage without having to pay it back. In Treatment 2, we introduce a cash reward granted to homeowners only once the mortgage has always been serviced up to a certain period, in the spirit of Edmans' (2010) Responsible Homeowner Reward.

Only a few papers model the mortgage default decision in a dynamic setting. Closely related to our theoretical model is the one developed in Campbell and Cocco (2015), who are interested in the effect of various nominal risks on default behavior, and thus consider a richer set of stochastic variables than we do. On the other hand, they do not model the decision of selling the house and prepaying the mortgage, which we take into consideration as an important option for the homeowner. In Campbell and Cocco's (2015) model, mortgage default is triggered by negative home equity only if the household is sufficiently borrowing constrained. They find that a higher loan-to-value ratio at origination increases the probability of negative home equity, and that high loan-to-income ratios increase the probability of default by making borrowing constraints more severe. Another recent dynamic model of the mortgage default decision is the one by Corbae and Quintin (2015), who solve for the mortgage market equilibrium to quantify the role of mortgage innovation on the increase in the foreclosure rate. They run simulations in which they analyze the effect of an unexpected 25% drop in house prices in an economy where non-traditional (subprime and/or variable payment) mortgages have been introduced, and compare it with an economy where these new mortgages were not offered. According to their computations,

the availability of subprime mortgages in the four years prior to the crisis explain 60% of the observed increase in foreclosures. We focus here on a different question, and choose a partial equilibrium approach, which allows us to analyze individual decisions in more detail and to conduct an economic experiment on borrowers' behavior in the lab.

Economics experiments exploring dynamic consumption/saving decisions under uncertainty similar to the one presented in this paper find that individuals do not generally behave optimally (according to the standard life-cycle model), and conclude that people are “boundedly rational” (see Hey and Dardanoni, 1988; Ballinger *et al.*, 2003; Carbone and Hey, 2004, among others). Despite this departure between observed and optimal behavior, though, the inter-temporal optimization model does succeed in predicting behavioral changes as a result of changes in the parameter values, i.e. in the comparative statics. Moreover, it is found that more optimal behavior can be reached with some learning (Ballinger *et al.*, 2003; Brown *et al.*, 2009). In our experiment, we focus our attention more on the discrete choice of default rather than on consumption/saving behavior, and we analyze the effect of different policies meant to decrease strategic default.

Brown *et al.* (2016) use an experimental setting to analyze default behavior and social norms in an economic crisis. To this end, they implement a one shot prisoner's dilemma in which the ability to cooperate is stochastic, thus creating fundamental as well as strategic default. They find that adverse economic conditions soften moral constraints leading to higher strategic default. Moreover, the enforcement of social norms (a sanction to defaulters) is made more difficult in an economic downturn, due to the higher informational uncertainty that characterize it. Differently from Brown *et al.* (2016), our experiment focuses on the intertemporality of the repayment decision, and on its link to saving/consumption choices, so that our experimental game is more similar to the one faced by homeowners.

In the following section we describe our model of mortgage default, and in section 3 we obtain the theoretical predictions. In section 4 we describe the experimental design. Section 5 presents the main results and Section 6 concludes.

2. A Model of Mortgage Default

In the following, we present a theoretical model of the household's mortgage default decision. We take into consideration the dynamic problem that starts at $t = 1$ when the household has already bought a house and acquired a mortgage, and lasts for the whole duration of the mortgage, until $t = T$, the period after the last payment. The agents face uncertainty on employment status and house prices, and choose at every period whether to make the mortgage payment, to sell the house and prepay the mortgage, or to default. They also decide how much to consume and how much to save for the future.

2.1. Individual preferences and endowments

The household receives utility from consumption c and housing service flows s , which are proportional to the size of the house owned or rented. The momentary utility function is the following:

$$u(c, s) = \log(c - \bar{c}) + \log(\theta_H s)$$

where \bar{c} is a minimum consumption level, $\theta_H = \theta_1 = 1$ if the agent owns a house ($H = 1$), and $\theta_H = \theta_0 < 1$ if the agent rents ($H = 0$). This assumption for θ_H assumes that the utility from owning a house is more than the utility from renting a house of the same size, as in Rosen (1985) and Poterba (1992). The log specification for the utility function is taken from Davis and Ortalo-Magné (1992) who find that the expenditure share on housing is constant over time and across cities. To simplify decisions, we assume only one house size ($s = \bar{h}$) for both owners and renters.

At every period, the agent can be employed or unemployed, receiving income $y = e$ and $y = b$ respectively, where b represents unemployment benefits paid by the state. Employment shocks follow a Markov chain, denoted by $p_{ij} = \Pr\{y_{t+1} = j/y_t = i\}$ for every $i, j \in \{e, b\}$.

The household faces uncertainty on house prices, which can assume two values: low (P^L) or high (P^H), with $P^L < P^H$, both lower than the initial price P^I at which the house has been acquired. House prices also follow a Markov chain, with a probability $q_{ij} = \Pr\{P_{t+1} = j/P_t = i\}$ for every $i, j \in \{P^L, P^H\}$.

Agents bought a house of total value $\bar{h}P^I$ for which they contracted a mortgage characterized by a series of mortgage payments $\{m_t\}_{t=1}^{T-1}$ and mortgage principals $\{M_t\}_{t=1}^{T-1}$.⁵ The downpayment for the house has already been paid at the beginning of the decision periods, and corresponds to a fraction λ of its value. Denoting with r^m the borrowing interest rate, mortgage payments are constant and are given by:

$$m_t = \frac{r^m}{1 - (1 + r^m)^{-(T-1)}} (1 - \lambda) \bar{h}P^I \quad \text{for } t = 1, \dots, T - 1.$$

The mortgage principal at the beginning of each period t (pre-payment) corresponds to the following:

$$M_t = \begin{cases} (1 - \lambda) \bar{h}P^I (1 + r^m) & \text{for } t = 1 \\ (M_{t-1} - m_{t-1}) (1 + r^m) & \text{for } t = 2, \dots, T - 1 \end{cases}$$

It is simple to verify that $M_T = 0$.

Households can trade a risk-free asset A_t which pays a known gross interest rate R , constant over time. They do not have any source of borrowing other than the mortgage ($A_t \geq 0$).

2.2. Household's choices

At each period, the agent decides consumption and saving, and one among the following three options:

- 1) Keep the house and make the mortgage payment, with budget constraint:

$$A_{t+1} = y_t + A_t R - c_t - m_t$$

- 2) Sell the house and pre-pay the mortgage debt. In this case the household incurs transaction costs ϕ proportional to the house value, and has to rent from now on until the end of the decision periods, T . In this case the budget constraint is:

$$A_{t+1} = y_t + A_t R - c_t + \bar{h}P_t(1 - \phi) - M_t - \bar{h}P_t^r$$

⁵We assume that the initial house value is high for everybody, since we are interested in analyzing situations in which agents are deeply indebted and house prices fall.

The rental rate P_t^r is assumed to be a fixed percentage of the house price, $P_t^r = \omega P_t$ at every t .

3) Default on the mortgage, paying a default cost Ψ and also renting until the last period, with budget constraint:

$$A_{t+1} = y_t + A_t R - c_t - \Psi - \bar{h} P_t^r.$$

We assume that there is a probability π that the lender obtains a deficiency judgment and forces the defaulter to pay the debt not covered by the collateral. The resolution of the deficiency judgment is known in the period subsequent to the default period and, in that case, the household must pay its debt in constant installments over the rest of its life.

The agent's objective function is equal to the expected discounted sum of the utility functions:

$$E_1 \left[\sum_{t=1}^T \beta^{t-1} u(c_t, s_t) \right]$$

where $\beta \leq 1$ denotes the discount factor.

At the last period, $u(c_{T+1}, s_{T+1}) = 0$ for every (c_{T+1}, s_{T+1}) .

The problem can be written and solved recursively using numerical methods. The dynamic problem solution for a homeowner consists of the policy functions $c_o^*(A_t, y_t, P_t)$, $A_o^*(A_t, y_t, P_t)$, $I^{osd*}(A_t, y_t, P_t) \in \{own, sell, default\}$ for consumption, future assets and the discrete decision of owning, selling or defaulting respectively. The renters' optimal choices are $c_r^*(A_t, y_t, P_t)$, $A_r^*(A_t, y_t, P_t)$. If the probability of "punishment" π is positive, then we need to keep track of two additional state variables: the house price P_τ and the age τ at the moment of default, which determine the value of negative equity and thus the constant installment to be payed in the case of being punished.

3. Model Results

We parameterize our model with the experiment in mind: parameter values are to match some basic features of the housing and mortgage market, but are also to be easy to communicate and explain to subjects. Moreover, the simulated model must give quite clear-cut results on strategic default behavior if we want to compare it to the choices observed in the experiment.

We set the persistence of employment to be equal to 0.90. If unemployed, the probability of finding a job is 60%. The unemployed individual experiences a 40% cut in earnings. Decisions are taken over a total of 10 periods. The mortgage downpayment is set to be equal to 15% of the initial value of the house, and the mortgage annual interest rate is 4%. The two shocks to house prices are such that home values can fall by 40% (when P^L is realized) or by 20% (when P^H is realized). We set the persistence of both these shocks to be 0.6. There are no deficiency judgments after default in the baseline T0 treatment ($\pi = 0$), while the probability π of punishment is equal to 0.50 in the first treatment T1. In T2 we introduce a “Responsible Homeowner Reward”, a bit larger than the mortgage payment of a given period, to those who have kept current on their mortgage payments for the first 4 periods of a life. A complete list of the parameter values used for the solution and simulation of the theoretical model can be found in Table 1.

Given these parameter values, we can solve for the model policy functions, which tell us the optimal choices for each combination of initial state variables characterizing the household (age, initial assets, employment status, etc.).

As an illustration, Figures 1 and 2 show the simulated choices of two selected individuals under different initial combinations of the house price and employment shock in period 1. Both individuals start with a house valued at 20, for which they pay a downpayment of 3. However, the individual in Figure 1 starts with a low realization of the income and house price shocks, while individual in Figure 2 receives the higher income and house price in period 1.

As can be seen from the graphs, the consumption and savings patterns of the two individuals closely follow their income path, given that the possibility of consumption smoothing is quite limited in the model by the fact that it is not possible to borrow (apart from the mortgage). In general, agents should try to build a buffer stock of savings in the first periods, and then dissave in the last years.⁶

Default in the model is always strategic and should happen in the first periods of the life of

⁶This saving path does not necessarily represent the typical life-cycle pattern, given that the duration of the decision process in our model represents the life of a mortgage rather than the life of a person.

the mortgage, characterized by (possibly deep) negative equity. Table 2 describes the optimal default decisions in period 1 as a function of the combination of employment and price shocks in that period.

We are interested in studying whether this kind of behavior can be observed in the laboratory, especially whether subjects' decisions are significantly different under the three treatments.

4. Experimental Design

The experimental design implements the assumptions and the parameterization of the theoretical model described above. We run two sessions with 76 to 80 participants per treatment, for a total of 235 subjects (42% female, aged 17 to 68), recruited using ORSEE (Greiner, 2015) among students and senior students of the Universitat Jaume I of Castellón (Spain). Experiments were programmed in Z-Tree (Fischbacher, 2007) and run in the Laboratory for Experimental Economics (LEE) at the same university. The average amount earned was of 36 euros, and sessions lasted about four hours including payment.

Participants are first allowed fifteen minutes to read the instructions and then the instructions are read aloud always by the same experimenter.

Following common practice (see for example Brown *et al.*, 2009), terms as “income shocks” and “utility” are avoided, and substituted by the more user-friendly “token income realizations” and “points”. Instead of “consumption” we use the more neutral term “points conversion” and we never mention the term “debt” or “saving” in the experiment. The house owned is defined as “(long-lived) asset A”, while the house rented is called “(short-lived) asset B” (an asset that you must buy every period).

Subjects observe their token income realization and the corresponding initial resources, the value of their asset A and information about the tokens they have to pay at each experimental period. They are then asked to make a choice depending on their initial status as a homeowner or, later in the game once they sold the house or defaulted, as a renter. If they own a house at the beginning of the period, they must decide among the three options of keeping the house,

selling it or defaulting on their mortgage, and must declare how much they want to save for the next period.

The program allows participants to experiment with numbers as long as they need before submitting their actual choice. It shows the possible consumption and current points earned for different values of saving and asset choices, together with the corresponding cash (savings plus interest) they would own at the beginning of the next period.

The points earned each period depend on the spending in that period and on whether the individual owns or rents a house, according to the parameterized utility function presented in the above sections, as shown in Table 3, which is also the numerical table given to subjects in the instructions.⁷

Each participant is assigned an initial combination of house and income shocks for the first age among the four possible ones: (y^L, P^L) , (y^H, P^L) , (y^L, P^H) and (y^H, P^H) . Each individual plays five subsequent life cycles. Each of the first four cycles starts with a different combination of (P_1, y_1) in period 1, allowing subjects to accumulate experience in all possible initial scenarios before playing in the fifth life a repetition of one of the first four combinations of initial state variables (only in period 1). In each life, the income and house price realizations from period 2 on are randomly drawn for each subject according to their stochastic process. According to Brown *et al.* (2009), subjects learn to behave almost optimally within four life cycles. Subjects are told that they will be paid at the end of the experimental session a money amount converted from the total points earned in one, randomly chosen, sequence of the first four, and the last sequence, according to the total sum of points earned in these two sequences. In the last period, the total value of cash and house owned are automatically converted into spending.

We run three treatments. In the baseline (Treatment 0), a defaulter must give up the house and pay the default cost, but is not liable of paying the part of the mortgage debt not covered by the collateral. In Treatment 1, instead, there is a 50% probability that the defaulter must pay his remaining debt with interest in constant installments, starting from the period immediately after the default. Last, Treatment 2 introduces a “prize” in the spirit of Edmans’ (2010) Responsible

⁷The parameterized utility function of the theoretical model was multiplied by 10000 to be more easily readable.

Homeowner Reward: a contingent cash reward, to be paid to the homeowner only once the owner has always repaid the mortgage up to period 4 (which corresponds to the last period in which negative equity is possible given the parametrization of the model). The prize is 5 tokens. Edmans (2010) argues that a similar contingent incentive would be much more effective (and less costly) than other solutions (as mortgage principal reductions) to solve the problem of strategic default. There is ample evidence in the experimental literature that individuals like and respond more strongly to rewards (Lazear, 2000, among others).

In each period of Life 5, we ask subjects which income and house price realization they expect to receive in the next period, thus eliciting their individual risk perception. After the end of the experiment, we conduct a risk aversion test (Sabater-Grande and Georgantzís, 2002) and the Differential Aptitude Test (DAT) - Abstract Reasoning to measure cognitive ability (Bennett *et al.*, 1974).⁸ Last, individuals are asked to fill in the following Questionnaire:

Assess the following statements according to a scale from 1 (strongly disagree) to 5 (strongly agree):

- a) People should pay back their debts.
- b) People do pay back their debts.
- c) I feel morally obliged to pay back all my debts.
- d) In certain situations, it is fair not to pay back your debts.
- e) People should have paid their debts in this experiment.

And answer to the following question:

f) What percentage of participants do you think have not paid back their debts in this experiment?

5. Experimental Results (Preliminary)

5.1. Theoretical vs. Experimental Behavior

⁸We use the Cordero and Corral (2006) Spanish adaptation of the original DAT.

For each period of each life, an experimental subject’s observed default behavior and consumption choices can be compared to the ones predicted by our theoretical model. Following the literature (Carbone and Hey, 2004, Meissner, 2016, among others), we compute optimal behavior in two different ways. First, given the same exact sequence of shocks realizations, we numerically solve for the best choices assuming the subject has always behaved optimally in the past. We call this *unconditionally* optimal behavior. The second approach consists in computing the optimal theoretical choices for the combination of initial states (assets, income and house price) characterizing the situation faced by each experimental subject at the beginning of each period, independently on whether the assets were the ones that maximized the stream of expected utility in the last period. This is the *conditionally* optimal behavior. We later test for significant differences among treatments.

Figure 3 shows actual consumption choices versus unconditionally and conditionally optimal consumption. Subjects tend to under-consume at the beginning of their lives, and over-consume at the end. This is in sharp contrast with evidence from life-cycle consumption/saving experiments, in which overconsumption is observed at the beginning of life. Meissner (2016), however, finds that underconsumption is observed when subjects need to borrow in order to reach optimal consumption levels. Our results suggest that individuals that start life deeply indebted (even if only in the context of a lab experiment) are reluctant to consume, an indication perhaps of debt aversion.

Subjects’ deviation from optimal behavior is lower for conditionally optimal consumption, given that in this case past “mistakes” are not taken into account. In the right panel in Figure 3, the coincidence of the consumption levels in the last period is due to the fact that all assets are automatically sold in this period, and converted into “points” (consumption).

From Life 1 to Life 5, we observe learning taking place (in accordance with Brown *et al.*, 2009), as can be also seen in Figure 4, which shows actual and unconditionally optimal consumption distributions in Life 1 and Life 5.

We parameterized the model so that it predicts a very high percentage of default, given initial conditions. This is done on purpose, because we are interested in creating an environment in

which individuals should strategically default if rational. Figure 5 contrasts observed versus conditionally and unconditionally optimal default decisions in each experimental life. Default in the lab happens in the first periods of life, as optimal, even if subjects tend to default less than optimal. In fact, we observe about 40% to 65% less default than what would be rational in the first period, depending on the initial shocks realizations (see the first two columns in Table 4, contrasting default rates in period 1). As in the theory, individuals taking part in the baseline treatment default (much) more when receiving the low income and the low house price shocks. The default rate of individuals characterized by (y^L, P^L) is 57%, while the one of the (y^H, P^H) type is 21% (the difference beingly statistically significant using a proportion test: z-value = 2.33 and p-value = 0.02).

Some learning is also taking place here, since default rates are slightly increasing with the experience acquired over lives (Figure 5).

Figure 6 compares actual and (conditionally) optimal default behavior in Life 5 of the three treatments. Both experimental treatments appear to be successful in reducing strategic default with respect to the control one, in the theory and in the data. A 50% probability of recourse leading to the repayment of the mortgage in excess of the house value at the moment of default leads to a 75% reduction of default in the laboratory, while this reduction is of 50% if a Responsible Homeowner Reward is introduced. Qualitatively, these effects follow what predicted by the theory. Table 4 shows the effects of the treatments by initial conditions in period 1 of Life 5. The decrease in default rates is statistically significant using proportion tests (z- and p-values reported in the table). Notice that treatments are effective in decreasing default especially for the individuals with low income, while in theory they should be more effective under low price shocks.

5.2. The determinants of the strategic default decision

Table 5 presents results from logit regressions of the default decision with vector corrected errors clustered at the individual level. The first two are standard logit regressions and use the data generated from the numerical solution of the model. The last two are random effects panel logit

regressions, with the experimental data. The dependent variable is always the default decision, equal to 1 if the individual defaults, 0 otherwise.

The regressors are the following:

Recourse: a dummy equal to 1 in Treatment 1, 0 otherwise.

RH Reward: a dummy equal to 1 in Treatment 2, 0 otherwise.

HYLP: a dummy equal to 1 if high income and low house price shock, 0 otherwise.

LYMP: a dummy equal to 1 if low income and high house price shock, 0 otherwise.

HYMP: a dummy equal to 1 if high income and high house price shock, 0 otherwise.

Initial Assets: the value of initial assets.

Period in Life: decision period, between 0 and 10.

Life: between 1 and 5.

Should pay: answer to Questionnaire point a), between 1 and 5.

Do pay: answer to Questionnaire point b), between 1 and 5.

Morally obliged: answer to Questionnaire point c), between 1 and 5.

Justified not to pay: answer to Questionnaire point d), between 1 and 5.

Should have paid: answer to Questionnaire point e), between 1 and 5.

% not paying: answer to Questionnaire point f), between 0 and 100.

Risk aversion: scale resulting from the risk aversion test (the higher, the higher the risk aversion).

Reasoning ability: number of correct answers in the DAT-Abstract Reasoning test, between 0 and 40.

Age: age in years.

Lab experience: equal to 1 if the subject has participated in laboratory experiments before.

Economics Major: equal to 1 if the individual is studying or has studied a degree related to economics.

Financial situation: Discrete variable indicating the financial situation of the subject's family: 1=we endure very hard times, 2= can just make ends meet, 3= live moderately well, 4= we are well off.

Female: equal to 1 if the subject is a female.

Coherent with the theory, subjects with high income and receiving the highest of the price shocks (HYMP) default less than subjects with low income and low house price (LYLP).

Also coherent with the optimal, when receiving the lower price shock, a higher income decreases default.

The existence of a probability of recourse discourages default, especially for low income individuals (while in the theory it should do so especially for low house prices).

The existence of a Responsible Homeowner Reward also reduces default, being more effective than in the theory (but less effective than the probability of recourse).

An important predictor of default is the perceived social norm in the experiment: individuals that believe that the default rate in the experiment is higher, default more.

Stigma, as deduced from a questionnaire, seems to have no role. Also gender, risk aversion or reasoning ability do not play a significant role.

Subjects who have more experience in lab experiments default more, while subjects with an Economics major default less.

6. Preliminary Conclusions

Subjects in the laboratory do not do a bad job in solving a dynamic optimization problem: they default in the right periods and quite fast learn what they should consume.

However:

- They default less than optimal (and social norm seems to be important);
- They consume less than optimal in the first periods of life: they are “cautious” when indebted, coherent with debt aversion and in contrast to experimental results in which individuals are faced with the saving/consumption decision only, without the possibility of borrowing;

Last, a positive probability of recourse and a Responsible Homeowner Reward are quite effective in discouraging default in the lab.

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Tables

Table 1. Parameter Values

PARAMETER	VALUE	EXPLANATION
T	10	Decisions periods
A_1	0.5	Initial asset level
θ_1	1	Weight on owned house in utility
θ_0	0.8	Weight on rental house in utility
ϕ	0.05	House transaction cost when selling as % of house price
\bar{h}	2	House size
\bar{c}	0.5	Minimum consumption level
w	0.05	Rental rate as % of house price
β	1	Discount factor
r	0	Risk-free interest rate
λ	0.15	House downpayment as a fraction of its initial value
r^m	0.04	Mortgage interest rate*
Ψ	1	Default cost
e	10	Earnings of employed
b	6	Earnings of unemployed
p_{ee}	0.90	Probability of staying employed
p_{bb}	0.40	Probability of staying unemployed
P^L	12	Low house price realization
P^H	16	High house price realization
P^I	20	Initial house price when contracting mortgage
q_{MM}, q_{LL}	0.6	Persistence of house price
π	0.5	Prob. of punishment in T1
$\$$	5	Prize for paying back the mortgage up to period 4 in T2

* Note: with this interest rate, the mortgage payment is equal to 4.57 from periods 1 to 9.

Table 2. Optimal default decision in period 1 as a function of initial conditions, by Treatment

INITIAL CONDITION	T0	T1	T2
(y^L, P^L)	Strategic default	Keep the house	Strategic default
(y^H, P^L)	Strategic default	Keep the house	Keep the house
(y^L, P^H)	Strategic default	Strategic default	Strategic default
(y^H, P^H)	Keep the house	Keep the house	Keep the house

T0=Baseline treatment; T1=Treatment 1 (50% probability of recourse); T2=Treatment 2 (Responsible Homeowner Reward)

Table 3. Numerical Table of the “Points function”

CONSUMPTION	POINTS IF OWNING	POINTS IF RENTING
0.5	3000	768.6
1	9931.5	7700
1.5	13986.1	11754.7
2	16862.9	14631.5
2.5	19094.4	16862.9
3	20917.6	18686.2
3.5	22459.1	20227.7
4	23794.4	21563
4.5	24972.2	22740.8
5	26025.9	23794.4
5.5	26979	24747.5
6	27849.1	25617.6
6.5	28649.5	26418.1
7	29390.6	27159.1
7.5	30080.5	27849.1
8	30725.9	28494.5
8.5	31332.1	29100.7
9	31903.7	29672.3
9.5	32444.4	30213
10	32957.3	30725.9
10.5	33445.2	31213.8
11	33910.4	31679
11.5	34354.9	32123.5
12	34780.5	32549.1
12.5	35188.8	32957.3
13	35581	33349.5
13.5	35958.4	33726.9
14	36322	34090.6
14.5	36673	34441.5
15	37012	34780.5

Table 4: Default in period 1 (Life 5): Optimal vs. Observed

Initial Condition	Strategic Default in T0 (Baseline)		Strategic Default in T1 (50% p. Recourse)		Strategic Default in T2 (RH Reward)	
	Theory	Experiment	Theory	Experiment	Theory	Experiment
(y^L, P^L)	100%	57%	0%	15% (z=2.8, p=0.003)	100%	21% (z=2.33, p=0.010)
(y^H, P^L)	100%	37%	0%	15% (z=1.56, p=0.059)	0%	16% (z=1.47, p=0.070)
(y^L, P^H)	100%	35%	100%	5% (z=2.37, p=0.009)	100%	5% (z=2.3, p=0.011)
(y^H, P^H)	0%	21%	0%	5% (z=1.5, p=0.067)	0%	32% (z=-0.74, p=0.769)
All		38%		10% (z=4.1, p<0.001)		18% (z=2.7, p=0.004)

Note: For each of the two treatments T1 and T2, between parenthesis are the z-value (z) and the p-value (p) of a one-tail proportion test comparing the default rate in period 1 of Life 5 between the baseline and that treatment.

Table 5: Logit Regressions

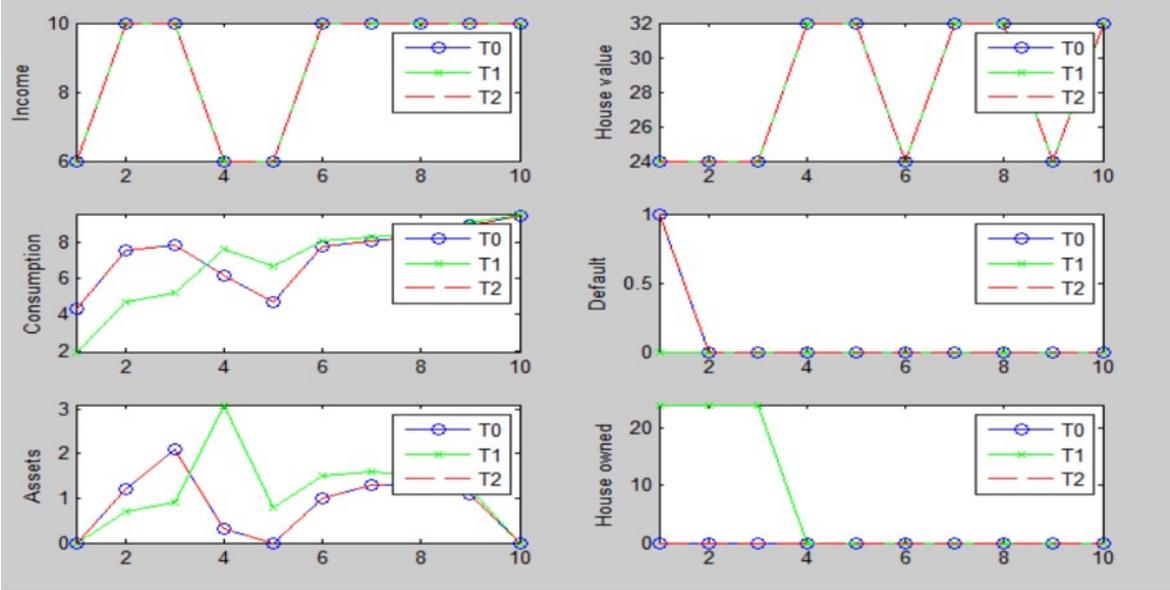
Variables	Optimal Default		Cond. Opt. Default		Obs. Default		Obs. Default	
	Coeff.	St. Err.	Coeff.	St. Err.	Coeff.	St. Err.	Coeff.	St. Err.
Constant	20.36***	3.35	9.94***	0.95	-0.89**	0.39	0.99	2.3
Recourse	-10.99***	1.54	-5.83***	0.55	-1.63***	0.42	-1.34***	0.41
RH Reward	-7.02***	1.08	-4.59***	0.41	-1.64***	0.46	-1.34***	0.44
HYLP	-6.26***	0.8	-4.66***	0.36	-1.01***	0.21	-0.99***	0.21
LYMP	4.84***	0.54	1.75***	0.31	-0.78***	0.22	-0.75***	0.22
HYMP	-28.15		-23.11***	0.53	-1.61***	0.26	-1.59***	0.26
Initial Assets	-12.86***	2.86	-2.11***	0.61	-0.04	0.06	-0.05	0.06
Period in life	-4.84***	0.74	-3.08***	0.26	-0.41***	0.07	-0.4***	0.07
Life	0.18**	0.08	0.09	0.07	0.12*	0.07	0.12*	0.07
Should pay							-0.36	0.3
Do pay							0.16	0.19
Morally obliged							0.11	0.25
Justified not to pay							-0.04	0.15
Should have paid							-0.23*	0.13
% not paying?							0.03***	0.01
Risk Aversion							-0.18	0.2
Reasoning Ability							0.01	0.03
Age							-0.02	0.02
Lab Experience							0.34**	0.14
Economics Major							-0.87**	0.39
Financial Situation							-0.42	0.34
Female							-0.12	0.36
Number of Obs	4324		6439		6439		6427	
Chi Squared			15700.34		129.55		165.14	
P-value			0		3.51E-24		2.23E-24	
Pseudo R Squared	0.92		0.82					

Logit regressions of the default decision with vector corrected errors clustered at the individual level. The first two columns show standard logit regressions using the data generated from the numerical solution of the model. The last two columns show the results of random effects panel logit regressions with the experimental data.

***=significant at 1%; **=significant at 5%; *=significant at 10%

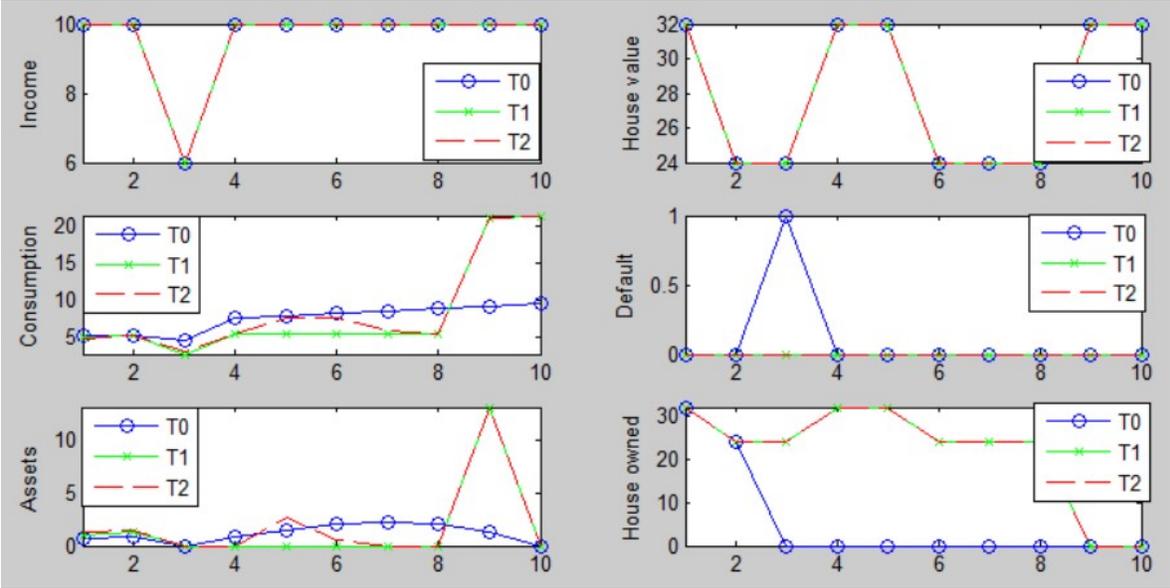
Figures

Figure 1: Simulated Optimal Choices for an individual starting life with low income (y^L) and low house value (P^L)



Note: Income and price shocks from period 2 on are randomly drawn according to their stochastic processes

Figure 2: Simulated Optimal Choices for an individual starting life with high income (y^H) and high house value (P^H)



Note: Income and price shocks from period 2 on are randomly drawn according to their stochastic processes

Figure 3: Actual versus Optimal Life-Cycle Consumption

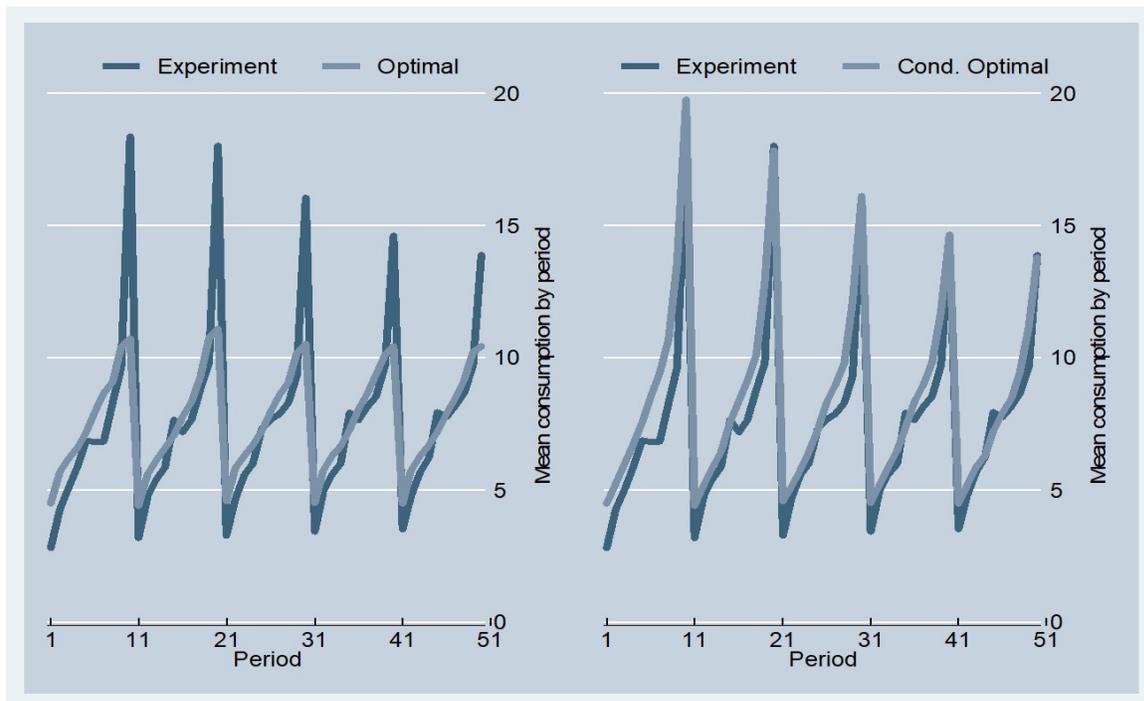


Figure 4: Actual versus (Unconditionally) Optimal Consumption Distributions, Life 1 and 5

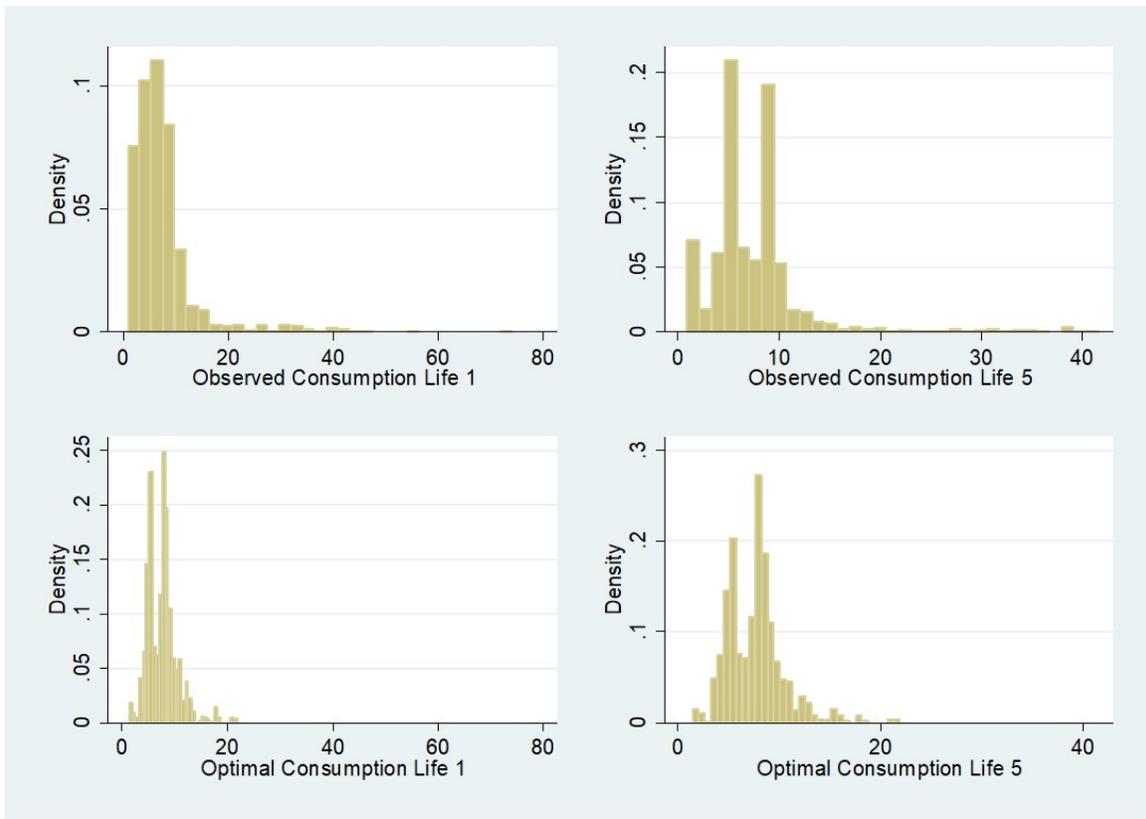


Figure 5: Actual versus Optimal Life-Cycle Default Behavior

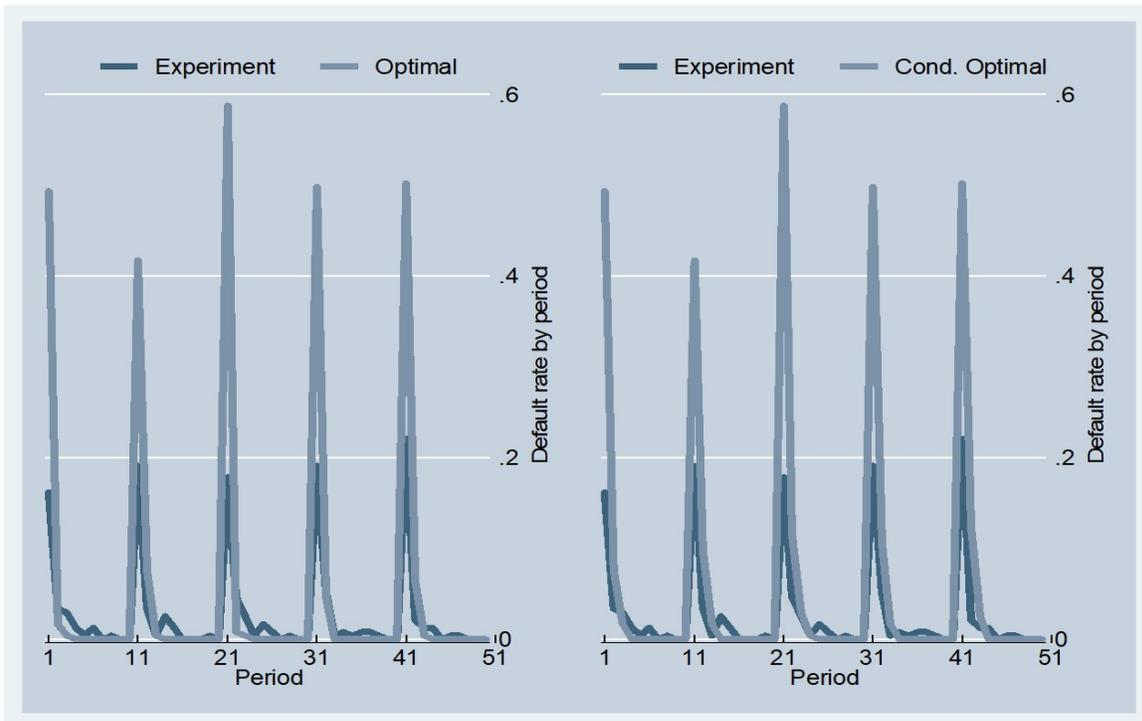


Figure 6: Actual versus (Conditionally) Optimal Default in Life 5, by Treatment

