High Default Risk on Down Payment Assistance Program: Adverse Selection Vs. Program Characteristics?

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Abstract

Various government programs have been developed in the United States to provide down payment assistance (DPA) to low-moderate income borrowers to help them achieve homeownership, but these DPA loans are often found to have a higher default risk than loans without DPA. My paper examines to what extent is higher default rates due to the selection of riskier borrowers into DPAs and characteristics of the DPA program itself. This study addresses this question using monthly panel data of the Ohio Housing Finance Agency's (OHFA) Mortgage Revenue Bond (MRB) first-time home buyer program with two forms of DPAs from year 2005 to 2009. To identify the cause of default, I use a two-step algorithm for dynamic games first proposed in Bajari, Benkard and Levin (2007). I first estimate the choice of DPAs using a multinomial logit model, and the probability of default using a survival model to examine the effect of assistance characteristics on loan defaults. Next I use the estimated survival function to generate borrowers' hypothetical choices based on simulated state variables, and use the simulated data to recover parameters of a dynamic model of loan default. These estimated parameters measure borrowers' relative utility and risk tolerance of non-housing consumption, and the result indicates that risky borrowers select into DPAs. Based on the results of my empirical and dynamic estimations, I find that both adverse selection and DPA program characteristics increase the likelihood of DPA loans defaulting. A policy implication is that to improve DPA loans' performance, we can either require a lower monthly debt ratio to reduce the risk that is created by the program characteristics, or impose a minimum credit score requirement to reduce the adverse selection. The second policy is more effective, but it may deprive many low credit borrowers' opportunity of achieving homeownership.

1 Introduction

Lack of wealth is one major reason that prevent households from purchasing a house[1], therefore many government programs have been developed in order to provide down payment assistance (DPA) to low-moderate income borrowers to help them achieve homeownership. For example, in the United States, there are 41 state housing finance agencies or authorities that provide assistance

[1]For example, Haurin, Hendershott and Wachter (1996) find that for their sample of young households, 37% of them suffered from borrowing constraints even when they choose a loan-to-value ratio to minimize the impact of wealth and income requirement. They show that for these households, the borrowing constraint reduces their probability of owning by 10 to 20% depending on households' characteristics.

in addition to their 30-year fixed-rate Mortgage Revenue Bonds loans (MRB loans)[2].

Questions arise, however about the increased default risk associated with DPA programs. Using a very current loan performance data from year 2005 to the end of 2009, which goes through the big turmoil in the housing market, this paper tries to understand subtle features of the DPA programs that lead to more default. In particular, I am going to address whether it is the adverse selection of risky borrowers into DPA programs, or it is some inherent characteristics of the program which induces the high default of DPA loans. The findings in my study can provide policy suggestions on how to design DPA programs to reduce the default risk while maintaining the effect of program on assisting low income home buyers.

I use data from a public mortgage program which offered two typical forms of DPAs. It provides a great opportunity to conduct a comparative study of how the characteristics of DPA programs affect loan performance[3]. Two forms of DPAs are offered: the DPA Grant (Grant) which increases the interest rate of the original loan, and the DPA Loan (Loan) which is a second mortgage loan. Borrowers are free to choose whether to accept a DPA and which particular one to use, and this decision must be made at the time of the loan application. If borrowers are rejected, they can not change their DPA choice and apply for a different loan, so a borrower without DPA will not be a borrower who wants a DPA but is rejected. My sample includes borrowers both with and without DPAs.

Usage of a DPA will reduce borrowers' down payment amount out of their own pockets, but increase the monthly payment and/or loan-to-value ratio (LTV). Table 1 explains the change of payment flow using different DPAs based on a mortgage loan of a $100,000 property. The LTV of the original loan is set to 90%, and the mortgage interest rate is 5%. The interest rate increases to 5.5% if DPA Grant is used. The interest rate on the second loan is 5.5% if DPA Loan is used. To make the results comparable, I also assume that both Grant and Loan amount are 3% of the home's purchase price. We can see that both Grant and Loan DPA increase monthly payment, but the Loan increases monthly payment less than Grant, and it increases the LTV ratio.

The adverse selection of risky borrowers into DPAs exists because borrowers make their choice of DPA to maximize their expected utility. Borrowers who otherwise have the same observable characteristics such as income and wealth, may have different preferences for housing and non-housing consumptions. The hypothesis is that borrowers who enjoy a relatively higher utility from non-housing consumption than housing services are more likely to select into DPA programs to smooth consumption, but they are also more likely to default if trigger events such income decrease occurs in order to maintain their non-housing consumption.

The inherent characteristics of DPA programs could also increase default risk as compared with

[2]The Mortgage Revenue Bonds are tax exempted, thus usually guarantees a lower mortgage interest rate than that of comparable conventional loans. See Table A-1 for a comparison of interest rates between MRB loans and conventional loans.

[3]Within those 41 states that offer DPA, 31 of them have similar programs either in the form of a grant or in the form of a second mortgage.

non-DPA borrowers, DPA borrowers put a smaller portion of their own asset down as equity in the property, and they face a higher monthly payment. Therefore, DPA borrowers are more prone to default when the economic condition changes (for example borrowers' income). The hypothesis is that if the inherent characteristics of DPA programs induce a higher default risk of DPA loans, then for borrowers who choose not to participate in a DPA program, if they are forced to choose a DPA, their probability of default will increase.

In order to separate the effect of adverse selection and program characteristics, I use a two-step algorithm for dynamic games proposed by Bajari, Benkard and Levin (2007)(BBL). In the first step, I use a multinomial choice model (logit maximum likelihood) to estimate the policy function of a household's one-time selection into a DPA, and a survival model to estimate the probability of default for three groups of borrowers (no DPA, Grant, and Loan) so that I can study the effect of DPA program characteristics by simulating loan performances forcing borrowers to change their DPA choices without changing borrowers' characteristics. The law of motion of state variables such as house price inflation and interest rate will also be estimated using vector auto-regression in order to simulate multiple future state paths.

In the second step, I start with forward simulation of borrowers' optimal default decisions by drawing 50 state paths (using my first-step estimated state transition probabilities). Next, I construct empirical counterparts of borrowers' optimal strategies by forcing borrowers to change their optimal DPA choices, and then predict borrowers' counter-factual default decisions based on their default policy function[4]. The utility difference (denoted as g) between the optimal response and the counter-factual response should be non-negative if borrowers maximize their utility. I define $Q = min(g, 0)$, so parameters of the structural model will be recovered by minimizing Q^2 over the state space.

Based on the results of my empirical and dynamic estimations, I find that both adverse selection and DPA program characteristics (such as higher monthly payment and LTV ratio) explain the higher default risk of DPA loans than non-DPA loans, but adverse selection is the reason why the Loan borrowers have a even higher propensity to default than Grant borrowers. A policy implication is that both a minimum credit score requirement and a maximum debt ratio requirement can reduce the default risk of DPA loans. While a minimum credit score is more effective at reducing the default probability, it deprives some borrowers' opportunity of becoming home owners. As a result, a maximum debt ratio policy might be better considering that the purpose of these assistance program is to help low income families achieve the home ownership.

The paper is organized as follows. Next section is a brief review of the literature. Section 3 introduce the model and the estimation technique. Section 4 describes the data and shows summary statistics. Section 5 discusses the estimation result of DPA choices. Section 6 provides the estimation results of loan default and simulated prediction of counter-factual loan performances. Section 7 presents the simulation results for the structural model and the policy implication. Section 8

[4]Variables such as monthly payment, and interest rate will be adjusted accordingly when borrowers change their DPA choices.

concludes.

2 Literature Review

A great amount of research has separately studied borrowers' choice of mortgage terms and mortgage loan performances.

Studies on the choice of mortgage terms consistently find that the borrowers characteristics have significant impact on their choice of terms. Mortgage terms like the length of the mortgage, or a fixed rate versus an adjustable rate mortgage, and the amount of down payment are all important decisions to make when borrowers apply loans. Sa-Aadu and Sirmans (1995) find that more mobile and younger borrowers tend to use short-term mortgages. Pennington-Cross and Nichols (2000) show that borrowers with credit problems are more likely to apply FHA mortgage loans because its more lenient writing standard, despite the higher cost of FHA loans. They find FHA borrowers' credit scores are on average lower than conventional loans, but as LTV ratio increases, the credit score difference decreases. Posey and Yavas (2001) uses a two stage asymmetric information model to show the existence of an unique separating equilibrium where high-risk (low-risk) borrowers choose ARMs (FRMs), but their model also suggests that this does not necessarily mean a higher default rate for ARMs, especially when risks are high. Borrowers' risk is measured by the probability of future income changes in their model. Campbell and Cocco (2003) show that fixed-rate mortgage is more attractive for a risk-averse household with a large mortgage, risky income, high default cost or low moving probability. Harrison, Noordewier and Yavas (2004) use a theoretical signaling model to show that borrowers' selection of LTV ratio depends on the default cost; when the cost is high, borrowers whose income is more likely to decrease self-select into lower LTV loans while borrowers whose income is less likely to decrease choose higher LTV ratio, but if the default cost is low, the reverse will be true.

There are also many studies on the mortgage default. Default put option value and property value have been found to significantly affect mortgage default. Examples include Deng and Gabriel (2006), which use option value to examine the hazard of loan termination. They find that borrowers with low income or low credits are more more likely to default than high income or high credit borrowers, and an increase of the default put option value magnifies the negative effect of low credit scores. However, they also find these low credit loans will be less likely to prepay, thus the net termination risk is damped, and investors should reduce the risk premium of lower credit mortgage pools. Guiso et al(2009) find the existence of strategic default as well when the value of the mortgage exceeds the value of the house, even when borrowers can afford the monthly payment, but no household would default when the equity short fall is less than 10% of the property value, thus households will not immdiately default on their loans when their house value is underwater, which rules out the "ruthless default" hypothesis.

Previous studies on assistance programs have also focused on the program consequence—higher default risks. Deng et al. (1996) study the default and prepayment behavior of homeowners in

a proportional hazard framework. Their simulation results indicate that public subsidy program cost will be increased by 2-4% if a zero-downpayment loans were priced as if they were mortgages with 10% down payment. Kelly (2008) focuses on the zero down payment mortgage default, and finds that delinquencies and claim rates are much higher of zero down payment mortgages than comparable loans with cash from the borrower. He finds that the increase of default risk caused by the assistance is the highest when borrowers receive assistance from a seller-funded Downpayment Assistance Provider.

So far, my study is the first one to combine the DPA choice and its consequence together and examine the cause of high default risk on public DPA programs in a dynamic framework. As shown in Yezer, Phillips and Trost(1994) the estimation of effect of mortgage characteristics on default is biased due to the self-selection and simultaneity of mortgage term choices. The usage of a dynamic structural model helps to identify the existence of adverse selection and understand why DPA loans are more likely to default. My study covers the period of year 2005 to 2009, which goes through the big turmoil in the housing market, and it provides policy implication on how to design the DPA programs in order to improve their performance.

3 Models for Down Payment Assistances and Loan Performances

Following BBL, a household's DPA choice, and loan default decision are modeled in a partial equilibrium, dynamic decision problem with a finite horizon. A households lives for T periods. At time 0, a household selects a house with a value of H_0, LTV ratio and whether to accept a DPA and which form to apply. In each subsequent period t a household decides whether to default on the mortgage loan. The total housing expenditure (including monthly payment on the mortgage, escrowed insurance and property tax payment) is an amount determined at time 0 if a household continues paying the loan (I assume that a household's real housing stock is fixed for the duration of the loan). This household then then chooses the expenditure on non-housing consumption, c_t. Household income Y_t is assumed to be exogenous, and saving is the difference of income and housing/non-housing expenditure. Households derive utility from housing stock both in a form of per period service flow (which is fixed for the life of the loan if a household does not default on its loan) and from the property value in the terminal period. The service flow is denoted as $g(H)$. I follow the literature by setting this service flow as a linear function of housing stock, so $g(H) = \kappa * H_0$. I set $\kappa = 0.075$, so that it is close to estimates of capitalization rate of residential housing in the literature[5]. If a household defaults on the loan, I assume that this household moves to a two-bedroom apartment, and needs to pay a rent[6], and $g(H) = R_t$. The property value in the terminal period will be set to zero for defaulted loans. The period utility function of a household is defined as:

[5]This highly standardized utility form and parameterization of housing service flow is also used in Bajari, Chan and Miller(2010).

[6]It is possible that households stay in the property for up to a year after they stop paying on the loan, but I do not have an explicit measure of default cost or relocation cost, so the rental price can be considered as a form of default cost even though they might still be staying in their foreclosed properties.

$$u(c, H) = log\big[(\theta c^{\tau} + (1-\theta)g(H)^{\tau})^{\frac{1}{\tau}}\big]$$

The most important parameters here are θ and τ which are measures of borrowers' relative risk tolerance, and they will be estimated separately for each DPA/non-DPA group. Households' decisions are made to maximize their intertemporal lifetime utility function:

$$U(\{c_t, H_t\}_{t=0}^{T}) = E_0\big[\sum_{t=1}^{T} \beta^{t-1} u(c_t, g(H_t)) + \gamma\beta^{T} log(H_T)\big] \tag{1}$$

where β is the standard time discount factor and γ is a measure for bequest motive of leaving H_t in the terminal period. Expectations at time zero (E_0) are taken with respect to the stochastic processes that are driving house price, fair market rent, interest rate, inflation and unemployment rate. These processes are specified and estimated in the following sections. The terminal period property value depends on the future house price appreciation and annual depreciations. I assume an annual depreciation of house value at the rate of 2.5% based on the result of Harding el al. (2007). As households derive utility from terminal period property value, this model also incorporates the investment motive of owning a house. Households can also accumulate wealth through savings S_t, which earns a risk free rate of i^{rf}.

A key requirement for a household to become a home owner is to meet the payment for the initial equity share in the house, which is equal to $1 - LTV$, and they also need to pay for the closing cost and other upfront costs, which is typically around 4% of the total loan amount. So the wealth constraint for households' initial wealth level W_0 is:

$$W_0 \geq (1 - LTV)H_0 + 4\%LTV * H_0$$

If DPA Grant is applied, the grant amount is added into W_0. If DPA Loan is applied, the amount of the second loan is added into W_0, and LTV is increased by $\frac{\text{2nd loan}}{\text{house value}}$. In each period following the closing of the mortgage contract, households face two types of budget constraints depending on their default decisions.

If a household decides not to default on the loan, the budget will be:

$$C_t + S_t + M_t = Y_t + S_{t-1} * (1 + {i^{rf}}_t) \tag{2}$$

where M_t is the monthly housing expenditure that includes monthly mortgage escrowed principal and interest payment, monthly mortgage insurance premium if applicable, monthly property tax, and other housing related expenses. If a household decides to default on the loan, they need to pay a rent of R_t, and the budget will be:

$$C_t + S_t + R_t = Y_t + S_{t-1} * (1 + {i^{rf}}_t) \tag{3}$$

Households choose to default on their loan at time t if the expected life time utility of defaulting at t is greater than not defaulting, or if their income plus saving are lower than M_t, that is they fail to meet the non-negative constraint on the consumption: $Y_t + S_{t-1} * (1 + {i^{rf}}_t) \geq M_t$. Based on my structural model, the cost of receiving utility from a housing property is the monthly housing expenditure. Therefore, the difference between the current market value of the house(Val_m) (which determines the utility of owning) and the market value of the mortgage loan (Mtg_m) will affect a household's probability of default. If $Mtg_m - Val_m$ increases, the probability of default should increase. This is consistent with the option theory of mortgage defaults in the literature[7].

4 Data and Descriptive Statistics

My data of down payment assistance choices and loan performance comes from the Ohio Housing Finance Agency (OHFA)[8]. This mortgage loan is provided to low income-moderate first-time home buyers with a 30-year fixed interest rate. My sample covers loans that were closed between 2005 and 2009, whose first payment was made before 2010. It has a total number of 35343 loans. The number of loans closed in each year, and the number and percentage of non-DPA, Grant and Loan mortgages are reported in Table 2[9] This data includes detailed information of a borrower's address (both the old address before they moved and the new address of the property they applied loans for), FICO score, other socio-economic characteristics, and the monthly loan payment history through December 2009. The longest loan history in my sample is 58 months, as the first payment usually starts two months after the time of closing.

The terms of the two DPAs offered by OHFA are very standard among most state Housing Finance Agencies/Authorities. For the Grant, OHFA will issue a grant for an amount up to 3% of the home's purchase price (this ratio changed from 2% to 3% from 2005 to 2009), which can be used to pay for the down payment, closing costs, or other prepaid expenses incurred prior to closing. If a borrower takes advantage of the grant, the mortgage interest rate will be 0.5% higher than OHFA's current mortgage rates. For the Loan, OHFA will issue a 15-year fixed interest rate loan as a second mortgage of up to 4% of the purchase price of the home. The interest rate on the second loan will be 0.5% higher than OHFA's current mortgage rate, while the interest rate of the first loan will remain unchanged.

To supplement my data, I also use the county level unemployment rate from the Bureau of Labor Statistics, the Fair Market Rent data (of 2-bedroom apartment) from U.S. Department of Housing and Urban Development, and the Consumer Price Index from the Census. My constant quality house price index is constructed using a hedonic house price model.[10] I combine the house

[7] See Deng and Gabriel (2007) as an example.

[8] Based on the Ohio Economic Survey, Ohio as a major test-market state, has a population that closely reflects the U.S. population as a whole. Therefore, findings based on OHFA's DPA program are applicable nationwide. The detail about this survey is in the Appendix B.

[9] The DPA Loan was not available until the second half of year 2005, therefore the percentage of DPA Loan is very small in 2005.

[10] The hedonic function analysis the relationship of the house price and the characteristics of the house. The regression model is as follows:

price index from the Federal Housing Finance Agency with my MSA level hedonic house price index. This procedure gives me data on the house price inflation and house price index that are comparable both across time and MSAs. I obtain the average conventional 30-year and 15-year fixed mortgage interest rates from Freddie Mac's Primary Mortgage Market Survey (PMMS). The descriptive statistics are reported in Table 3 by non-DPA, all DPAs, DPA as a grant (Grant) and DPA as a second mortgage (Loan) groups, and also by the closing year of mortgage loans.

The descriptive statistics show that characteristics of borrowers differ across groups. The DPA Loan group has the highest average household income in all years among three groups, and the Grant group has the second highest household income in year 2005. However, non-DPA borrowers have the highest monthly income per household member for all closing years except 2005, as DPA borrowers on average have a larger average family size. The average ages for MRB loan borrowers are within the range of 31 to 33 from 2005 to 2008, and DPA borrowers on average are older than non-DPA borrowers. The DPA borrowers have a lower mean FICO score. The race and ethnicity composition of borrowers are also different across three DPA groups. Combined together, a larger percentage of borrowers with 2 DPA forms are non-Hispanic black households, but a smaller percentage of borrowers with DPAs are Hispanics. The percentage of non-Hispanic black and Hispanic households in my sample is consistent with the race and ethnicity composition of Ohio.[11]

Loan characteristics differ among three groups of borrowers as well. The mean LTV ratio[12] is high for all groups, but compared with non-DPA loans DPA loans have a even higher LTV (around 99% before 2007, which slightly decreased to 98.2% in year 2008, while non-DPA loans have an average LTV ratio between 97% to 98% in year 2005-2007, and this ratio decreases to around 95% in 2008. Interest rate wise, for MRB loans, borrowers who applied on the same day get the same interest rate, but DPA Grant loans have an increase of interest rates from 0.35% to 0.5% point on the original loan so we observe that the interest rate on the original loan is the highest for DPA Grant loans. Non-DPA borrowers have the highest mean property value and monthly house expenditure from 2006-2008, which includes the monthly mortgage payment, insurance, property tax and other housing related expenditure. However, except for 2007, DPA borrowers tend to have a higher monthly debt payment than non-DPA borrowers, which implies that DPA borrowers have a higher non-housing debt compared with non-DPA borrowers. DPA Grant users have the lowest loan amount. Location wise, DPA grant borrowers' properties are less likely to be located in a MSA.

$$lnV_{is} = X_{is}\beta + state_s + \epsilon_{is}$$

where V_{is} is the market value of house i in MSA s. X_{is} represents the characteristics of the house including the number of rooms, the number of bedrooms, whether the housing unit is a condo, the acreage of the house (which is an indicator of whether the house is larger than 10 acres), the plumbing facilities in the house, the age of the structure, the unit structure and the dummies for the states (FIPS code for states are used). The data from the Census 2000 is used here. The regression results are shown in Table A-2. The coefficients for the state dummies will be the index for constant quality house price. The logarithm form facilitates the construction of house price index, because house price of state s equals $constant * e^{\text{the dummy variable coefficient of MSA s}}$, and the constant term can be removed. An example of study on the hedonic house price model is Goodman (1995).

[11] In 2009, 11.87% of Ohio's population are non-Hispanic black and 2.83% are Hispanics.

[12] This is the LTV of the original loan. The second loan is not included here.

The key statistics for my study are those of loan performances, namely, the percentage of default and delinquency[13]. The DPA loans have a higher percentage of default and delinquency compared with non-DPA loans. Moreover, the Loan loans always have the highest rate of default and delinquency among all loans.

Similar patterns can be seen in Figure 1, which is the Kaplan-Meier hazard rate of loans by DPA choice. Figure 1 shows that DPA loans are more likely to default than non-DPA loans, and among DPA loans, DPA Loan is more likely to default than DPA Grant. The hazard rate reaches the maximum after around 45 months for all loans, which could be caused by the sample limitation[14]. It can also suggest that the conditional hazard rate of default is not monotonically increasing. It first increases and then decreases[15].

To summarize the above findings, loan and borrower characteristics differ among non-DPA, Grant, and Loan programs, and loan performances differ as well, which raises up this question: did riskier borrowers select into DPAs, therefore DPA loans have a higher percentage of default, or DPA loans are more likely to default because of program characteristics such as higher monthly payments and lower equity share in the property, or both are explanations of the higher default risk on DPA loans? This will be answered by the estimation results from the policy function of DPA choices, default decisions and the parameters of the dynamic structural model in the following sections.

5 Estimation of Down Payment Assistance Choices

Multiple factors affect households' DPA choices. First of all, because borrowers are required to put some minimum amount down proportional to their house value, households with a lower level of saving are more likely to choose a DPA to meet this requirement. As I do not have information on households' wealth level, I include borrowers' age, household size, and the non-housing debt-income ratio to proxy households' wealth level instead. The reason for choosing these variables is that controlling for current household income, a family of a larger size would have a lower wealth level as the household expenditure increases. Older borrowers are expected to have a higher wealth level on average as they would have worked and saved for longer. Households with a higher level of monthly debt ratio are less likely to accumulate wealth, compared with households with a lower debt.

Secondly, borrowers are more likely to choose DPAs when the relative cost of getting DPAs is lower, or the benefit of getting DPAs is higher. As the decision to become a home owner affects a household's lifetime utility, under the assumption of rational expectation, a household should

[13]In this study, a loan is categorized as defaulted loan if the foreclosure procedure is complete. The foreclosure process usually takes longer than a year. Loans can recover after going into foreclosure process.

[14]Table A-3 shows the number of loans by their total payments. No more than 400 loans have more than 54 payments.

[15]This hump-shape pattern is found in many studies on mortgage default. For example Deng,Quigley and Van Order (1995).

make the decision of down payment assistance based on their expectation of future income path, interest rate, and house price appreciation. My data only provides the household income at the time of mortgage closing. My proxy of borrowers' expected future income shocks is based on the unemployment rate. I use the monthly data from the Bureau of Labor Statistics from January 1991 to August 2010 to calculate the mean and standard deviation of unemployment rate on the county level. Next, I calculate the deviation of unemployment rate at the time of closing from a county's mean level and use the deviation as a proxy for future income shock.

Interest rates and loan types also affect the relative cost of DPAs. Three different interest rates are relevant for DPA choices: the MRB loan interest rate without the DPA, the conventional 30-year fixed mortgage rate, and the conventional 15-year fixed mortgage rate. Instead of including all three interest rates in the estimation, I construct a variable that measures the difference of MRB loan interest rate and the average market interest rate for 30-year fixed rate mortgage. I do so because when MRB loans are comparatively more expensive than conventional loans, MRB borrowers are more likely to be those who need down payment assistance. Loan types matter because MRB borrowers need to select a loan type and get approved based on the underwriting standard of that particular loan type. Types of loan are included as a dummy variable[16].//
House price affects the relative cost of being a home owner, so I control for both the house price and the house price inflation. I also control for MSAs to capture the differences of house price level and changes across MSAs.

Suppose that the utility of DPA choice $j(j = 0, 1, 2)$ is:

$$U_{ij} = Z_{ij}\theta + \varepsilon_{ij}$$

A borrower chooses DPA j, if and only if $U_{ij} > U_{ik}$ for all other $k \neq j$, so the statistical model is driven by the probability that choice j is made, which is:

$$Prob(U_{ij} > U_{ik})\text{for all other}k \neq j$$

A multinomial logit model assumes that the disturbances are independent and identically distributed with extreme value distribution. Let $Z_{ij} = [x_{ij}, w_i]$ where x_{ij} are choice specific variables, w_i are individual specific characteristics, and A_j is a set of dummy variables to allow individual specific effects, then the estimation model is:

$$Prob(Y_i = j) = \frac{exp(x_{ij}\beta + w_i\alpha)}{\sum_{j=0}^{2} exp(x_{ij}\beta + A_j w_i \alpha)} \tag{4}$$

Estimation results are reported in Table 4[17]. The marginal effect is also reported in Table A-4 The baseline choice is non-DPA (loans without DPA), therefore a positive coefficient of variable X in DPA_j's ($j = 1$ or 2)model means an increase of X increases the probability of choosing DPA_j over non-DPA. Most of the estimated coefficients have the expected signs.

[16]The types of loans are: 1= FHA loans, 2= VA loans, 3= Conventional loans without Private Mortgage Insurance (PMI), 6= Conventional loans With PMI, and 9=Farm Loans.

[17]The coefficients of MSA dummies are available upon request.

All variables associated with a lower wealth level increase the probability of choosing DPAs instead of non-DPA. Households with a higher non-housing debt ratio are significantly more likely to choose a DPA, and the probability of choosing Loan is higher than Grant. The reason could be because Grant in general requires a higher monthly payment than Loan assistance, and borrowers with a high level of non-housing debt can not afford to increase their debt burden further. These borrowers need to trade off a higher equity ratio with a lower monthly payment. Household size increases the probability of using DPAs as expected, but the effect is not significant for Loan. Age has a positive effect on choosing loans with assistance, but the effect is not significant for Grant. Borrowers with a higher property value are less likely to choose DPAs, as buyers of more expensive properties tend to be wealthier. As Grant DPA increases the interest rate for the original loan amount, and a higher property value will cause a larger increase on the monthly payment, therefore the negative effect of property value is higher for the Grant. Loans with a higher loan-to-value ratio are more likely to be DPA loans, because a wealth constrained borrower is more likely to have a higher LTV. Race and ethnicity variables do not have significant effect on Grant choices, but being a Hispanic borrower significantly decreases the probability of choosing Loan over non-DPA. A possible explanation is that Hispanic borrowers in this program are more risk averse than other borrowers, and prefer to have a lower debt obligation.

A higher initial income significantly increases the probability of choosing a DPA. The reason could be that households have an incentive to smooth the non-housing and housing consumption, so households with a higher income would want a higher monthly payment on housing, therefore are more likely to choose DPAs. For variables that proxy for future income changes, a positive deviation of current unemployment rate from its mean increases borrowers' propensity to choose Grant over non-DPA, but decreases borrowers' propensity to choose Loan. The effect is mixed as a positive deviation of unemployment rate from its mean level means a negative income shock, thus borrowers want to take on less monthly debt. On the other hand, it can also indicate a possible future income increase, so it would increase borrowers' propensity to choose DPAs to smooth future consumption.

The effect of a higher house price inflation is to increase probability of choosing loans with DPAs. But higher house price level decreases the probability of choosing DPAs over non-DPA. The effect of house price is negative on DPA usage because in areas where house price is high, only relatively wealthier households would want to be home owners[18], so they are less likely to use DPAs. But a higher house price inflation increases the probability of choosing DPAs because the relative cost of using DPA is lower if house value is expected to increase.

I also find that FHA insured loans are more likely to be loans with DPAs, and any other loan types are more likely to be loans without DPAs. This could be the result of FHA's more relaxed underwriting standard, so borrowers with wealth constraint have a higher probability of getting loans approved through FHA, and these borrowers will also be more likely to use DPAs. The

[18]Painter and Yu (2008) find that living in gateway cities where the living cost is high reduces the probability of becoming a homeowner.

negative effect of the credit score could also be related to the relaxed requirement when borrowers apply DPAs, so lower credit borrowers choose DPAs to increase the probability of loan approval.

Interest rate effects are more complicated. The variable $i - FRM30$ for the difference between MRB loan interest rate and the conventional 30-year fixed mortgage rate increase the probability of choosing Loan DPA as expected. However, the increase of mortgage interest rate for Grant DPA increases the relative cost of using it. As a result, when $i - FRM30$ is higher, borrowers are more likely to choose Loan but less likely to choose Grant compared with no DPA. The conventional 15-year fixed mortgage rate does not affect Grant choice significantly, but it has a positive effect on the usage of Loan. This is expected as DPA Loan is a 15-year fixed rate loan, so the higher the conventional rate is, the lower is the relative cost of using DPA Loan.

To summarize the above findings, the probability of choosing a DPA is higher when borrowers are more wealth constrained, have a bigger incentive to smooth their consumption or when the relative cost of using DPA is lower. Moreover, since we do find that borrowers with certain characteristics are more likely to choose DPAs than non-DPA loans, it is important to identify whether DPA loans are more likely to default because DPA borrowers are riskier, or it is the program characteristics that result in more defaults, which would imply a need to redesign the program properly.

6 Effects of DPAs on Loan Defaults

6.1 Factors That Affect Loan Performances

To avoid the bias in a single equation estimation of the DPA choice's effect on loan performances, I study the loan performance of each DPA and non-DPA groups separately, and using multiple observations of each loan adjusting for error terms to control for the selection. I use the estimated default policy function to predict the probability of loan default had a borrower chosen a different type of DPA or no DPA, adjusting the monthly payment and the equity ratio accordingly.

To better trace the loan performance in each period of time, instead of using each loan as a single observation, I split each loan on a quarterly interval[19]. I take each January, April, July, and September as observation points for loan payment. If a loan enters in time between two points, then the time a loan enters will be taken as the first observation point. A loan will be dropped out of the sample if default happens. Next, I match the quarterly economic variables such as interest rate, house price inflation, house price index, 2-bedroom fair market rent and consumer price index with loan performances either by county or by MSA.

I use information of interest rates, and house price inflation to calculate the value of put option of loan default. The intrinsic value of a default option is defined as:

[19] A quarterly interval is chosen because it gives enough loan performance observations, and shows enough variation of most economic variables.

$$
\begin{aligned}
Option_t &= ln(\text{market value of mortgage loan}_t) - ln(\text{market value of the property}_t) \\
&= ln(\sum_{t}^{T}(\frac{P}{(1+FRM30_t)})) - ln(\frac{Val_{t_0} * HPI_t}{HPI_{t_0}}) \qquad (5)
\end{aligned}
$$

where P stands for the the monthly principle and interest payment, $FRM30_t$ is the current market rate of a 30-year fixed interest rate mortgage loan, and Val_{t_0} is the property value at the time of loan closing[20].

The option theory of loan default states that as the option is more in the money, a loan is more likely to default.[21] This is also consistent with my structural model prediction. If the property values or the market interest rate decreases a lot, the utility of making the loan payment could become smaller than defaulting, thus it is optimal for a household to default. However, how much an option should be in the money (which means the market value of the mortgage is higher than the property market value) for default to happen depends on a borrower's equity share in the property. Since borrowers enjoy utility of the housing stock as well, the utility loss of default is higher when borrowers' equity share in property value becomes larger, so the same option value, borrowers with a lower equity are more likely to default. Therefore, both option value and equity share are important in predicting defaults.

The relative cost of owning should also affect the decision of default[22]. Therefore the relative price of renting is included in my estimation of loan default. I restrict the rental unit to be a two-bedroom apartment. Whether a property is located in a MSA can affect the user cost as well, thus affect the probability of loan default.

The income of households is not reported except at the contract closing time, but it is a very important determinant of mortgage default. If a household income falls, in order to make the monthly payment on time, the non-housing consumption must be reduced. A suboptimal non-housing versus housing consumption ratio will reduce a household's life time utility, thus cause a household to default. Moreover, since the consumption has a non-negative requirement, a large decrease of income will force a household to default. In order to capture the possible changes of income after mortgage closing, I include the county level unemployment rate to capture the income shock. A higher unemployment would increase the probability of loan default as borrowers' income is more likely to decrease. The age of borrowers is also used because on average income increases with work tenure, which correlates with age. Monthly expenditure, non-housing debt and household size are also included in the estimation.

FICO score affects the probability of default in two ways. First of all, if a trigger event occurs that

[20]The calculation of current market value of loan of Loan is more complicated because it includes a second 15-year fixed rate mortgage, which needs to be added into the value of mortgage loans.

[21]See Deng and Gabriel (2006).

[22]The standard user cost model of homeownership claims that the probability of owning depends only on the relative cost of owning compared to renting, assuming that it is for the same household occupying the same house either as a renter or as an owner. See Hendershott and Slemrod (1982) as one example.

causes borrowers' income to fall below their debt level, it is easier for a borrower with a higher FICO score to finance his debt obligation through other channels rather than defaulting; secondly, the impact of default on high credit score borrowers is larger than low credit score borrowers, as default reduces credit scores and increases borrowers' cost of future financing (referred to as default cost). Race and ethnicity can affect default if it is more difficult for borrowers of certain race and ethnicity to finance through other channels than other races and ethnicities.

Variables that might be related to some loan specific characteristics such as the type of loans are also included to capture some missing factors that could affect loan performance. The value of the property at the time of closing is included as effects of equity and option value on defaults can depend on the original property value.

6.2 Estimation Model

I use each observation as a censored observation (both left and right censored, unless it is the first payment of a loan), and adjust the error term by the loan number. My observation time period is from January 2005 to December 2009, so the longest observation a loan can have is 58 months[23]. A loan drops out of the sample if a default occurs.

I use a parametric model to estimate the duration of a loan, and the hazard rate, which is defined as the probability of default at time t conditioned on having survived to time t. I select a parametric model instead of a semi-parametric Cox model because the proportional hazard assumption fails based on the test of Schoenfeld residuals. I choose loglogistic accelerated failure time (AFT) model based on Akaike's Information Criterion (AIC), which is defined as $AIC = -2ln\mathfrak{L}+2(k+c)$, where $\mathfrak{L}$ is the model's log likelihood, k is the number of model covariates and c is the number of model-specific distributional parameters. The model with the smallest AIC score is the best[24]. Another advantage of using loglogistic model is that it allows for non-monotonic unimodal hazards. If the shape parameter of this model (it is also denoted as γ in a slight abuse of notation to keep it consistent with STATA's report) is smaller than one then the conditional hazard first rises, then falls. If γ is bigger than 1, then the hazard is monotonically declining. Based on my structural model setting, γ is expected to be smaller than 1. The reason is that in the beginning period, households face changes of neighborhood, monthly expenditure etc., thus trigger events such as the increase of the put option value should have a large effect on the default decision, however as the equity share in the property value increases, the effect of trigger event will be reduced. This pattern is also found in Capozza et al. (1998).

By using a loglogistic AFT model, I assume a linear relationship between the log of survival time T and characteristics of the loan, X_{it}:

$$ln(T) = X\beta + \gamma u \tag{6}$$

[23]The first payment starts at least two months after the closing time
[24]The AIC score for each parametric model for my estimation is available upon request.

Where u has a density function of $f(u) = \frac{e^u}{1+e^u}$, and γ is the scale facto come (I use the log of income to capture its non-linear effect). Estimation results for three groups (non-DPA, Grant and Loan) are shown in Table 5. Since it is an AFT model, a positive coefficient implies a lower hazard rate and a higher expected duration conditioned on the loan having survived until t.

I find the effect of income on loan survival time is significant across three groups. A 1% increase of household income increases the expected loan duration by 4.9% for both non-DPA and Grant borrowers[25], and 3.2% for Loan borrowers. Effects of age cohorts significantly increase the survival time as well. And the increase is the largest for the age cohort from age 25 to 40, which is consistant with the trend observed in the labor literature on the patterns of income increase over life time. A smaller household size also increases the duration of loans, because a larger family should require a higher expenditure on non-housing goods, thus with the same income level, they are more likely to default.

The effect of option value is also significant: a 1% increase of the option value decreases the expected duration by 0.028%, 0.003% and 0.035% respectively for three groups. Because my definition of option is how much percentage is the loan value higher than the property's market value, the effect of the option value is in fact quite large. For example, based on the mean option value of non-DPA borrowers, the loan value is 4.6% lower than the property's value, so a $5000 increase of mortgage value on a property of $100,000 (the mean is around $111,000) reduces the expected duration of the loan by more than 6 months. A larger equity share increases the duration of the loan, but the effect is not significant for DPA borrowers. This could be caused by my short observation period, and the small variation of equity share in the first five year of DPA loans. Since the average LTV ratio is around 98% for my sample, and 90% of loans have LTVs between 86% and 1, the LTV differences between defaulted loans and surviving loans are very small. But the signs of equity and option are consistent with my model prediction.

FICO score increases the expected duration for all borrowers, and the effect is the largest for the highest FICO score group: 740 and above. As a result, imposing a minimum credit score will increase the expected duration of loans, and thus improve the loan performance.

Effects of racial and ethnic variables are not significant except for being black households on DPA Loan mortgage duration, and this effect is even reversed for Grant loans. Therefore, there is not enough evidence that borrowers from minority groups are more likely to default in my sample. I do not find the effect of loan type to be significant either, which is consistent with the fact that borrowers get the same mortgage interest rate if they apply at the same time so there should not be any difference after controlling for income and monthly expenditure.

The estimation model performs fairly well in tracking the pattern and changes of loan defaults in the data, as can be seen in Table 6. The model's prediction for non-DPA borrowers' default rates is the best among three groups. The model tends to over-predict from months 12-18 and after month 48. However, because my sample has fewer number of observations with durations longer

[25]The elasticities of independent variables are reported in Table A-5

than 48 (see Table A-3), the lower rate of default in the data could be the result of small sample bias.

6.3 Predicted Hazard and Simulated Responses

The loglogistic model's prediction of loan default hazard is shown in Figure 2. Two DPA loans start with the default hazards close to each other, and the hazard of DPA Loan mortgages increases faster as the loan duration increases, but the rate of the increase is getting smaller. DPA Loan mortgages always have the highest hazard rate of default, followed by Grant, and non-DPA loans always have the lowest hazard, which is the same as in the data.

Next, I use the estimated default policy function to examine the effect of DPA program characteristics on loan default risk. I predict the counter-factual loan outcomes by forcing a borrower to choose a different form of DPA or no DPA. I then recalculate the new option value, equity share, monthly house expenditure, and property value for each original DPA and non-DPA group according to the new DPA choice. The hypothetical monthly payment of non-DPA borrowers if they apply for Grant is calculated by keeping the loan amount and applying the Grant interest rate. If non-DPA borrowers apply for Loan, I assume that the amount of the second loan is the same as the Grant to make the result comparable, and the hypothetical mortgage value will be calculated based on both the monthly payment of the original loan and the second loan. I apply the new variables to the estimated coefficients of the survival model and predict the simulated hazard of each DPA or non-DPA group. Results are shown in Table 7.

I report both the predicted default rate and the simulated default for comparison purpose. Columns named "Original" refer to borrowers' original choices. For non-DPA users, switching to Grant or Loan increases the likelihood of default after two years, and the default rates of switching to Grant and Loan are almost identical. For Grant and Loan borrowers, switching to non-DPA will always improve the loan performance as borrowers are forced to down size their house and the monthly house expenditure will be reduced. What is surprising is that for Grant borrowers, the loan performances can be improved if they had chosen the DPA Loan instead. This could be the result of the interest rate decrease from 2008 to 2009, which makes the 0.5% point mortgage interest rate increase on the whole original loan amount much more costly than just on the amount of the second loan. For the same reason, we also find the DPA Loan borrowers' default rate increases slightly when they switch to DPA Grant.

Simulated results (especially from non-DPA loans, as loan amounts are kept unchanged) confirm that holding variables such as income and property value constant, applying a DPA (either Grant or Loan) increases the probability of default. This implies that a policy of reducing monthly debt to income ratio can improve the loan performance. The difference between Grant and Loan program is a trade off between a higher monthly payment and a lower equity ratio. My simulated results show that program characteristics of the Loan do not induce it to be more likely to default than Grant, therefore the higher default risk of DPA Loan could be caused by the adverse selection

of borrowers, which can be identified through my dynamic model parameter estimation.

7 Forward Simulation and Estimation of Structural Model Parameters

First, I will introduce the estimation method proposed by Bajari,Benkard and Levin (2007) and adapted to suit my estimation purpose. In the dynamic model of the DPA choice and the loan default, a household makes the decision to maximize his utility. Define:

$$g(x, \theta, \alpha) = V_i(s; \sigma_i, \sigma_{-i}; \theta, \alpha) - V_i(s; \sigma_i\prime, \sigma_{-i}; \theta, \alpha) \tag{7}$$

where x is the equilibrium condition of (i, s, σ_i') combination, σ is the strategy of the loan amount, DPA choice and default decision[26], and α are parameters of policy functions estimated in the first stage, and parameters that govern state variable processes, which is described later. θ are parameters to be recovered, and s is the state. So $g(x, \theta, \alpha)$ is the difference of value function V_i of two strategy $sigma_i$ and $sigma_i\prime$. I use forward simulation to get the empirical counterpart of $g(x, \theta, \alpha)$, $\hat{g}(x, \theta, \hat{\alpha}_n)$ by replacing V_i with $\hat{V}_i$. Let n denote the number of simulation draws. Define:

$$Q_n(\theta, \alpha) = \frac{1}{n} \sum_{k=1}^{n} min(\hat{g}(X_k, \theta, \hat{\alpha}_n, 0))^2 \tag{8}$$

Then the estimator should minimize this objective function at $\alpha = \hat{\alpha}_n$, or $\theta = \hat{argmin}_{\theta \in \Theta} Q_n(\theta, \hat{\alpha_n})$. The alternative policy functions in my model are set by forcing a household to make a different DPA choice, therefore there are two alternative policy functions for each household. I randomly select 10% of my original sample[27] and draw 50 states based on the state variables at the time of closing. Next, I split loan observations at quarterly interval, and forwardly simulate the probability of default for 20 observation periods. That is to say for each loan I simulate the loan performance for 5 years. The 20-quarter simulation is chosen as the forward forecasting of state variables such as unemployment and CPI for long periods are not reliable. So the last period's utility will include the equity share of property value at period 20. Without data on the wealth level and non-housing consumption, I reduce the strategy space by assuming no savings.

The method of drawing 50 states is as follows. First, I model the time series process of 30-year fixed mortgage interest rate $FRM30_t$, and house price inflation π^h as a Vector Auto-Regression with one lag for each MSA. Error terms have a bivariate normal distribution. The estimated coefficients of the VAR models are reported in Table A-7.

[26] I simplify the strategy space in the way that the loan amount is fixed for non-DPA borrowers, and for DPA borrowers it is a choice of large loan amount with a DPA or small loan amount without a DPA.

[27] This is necessary for the capacity of estimation programs can not accomodate the full sample with 50 simulated states and 20 observation periods. The 10% random sample I choose is representative of the full sample, which can be seen from Table A-6

$$
\begin{aligned}
FRM30_t &= \beta_{11} + \beta_{12} FRM30_{t-1} + \beta_{13} \pi^h_{t-1} + e_{it} \\
\Pi^h_t &= \beta_{21} + \beta_{22} FRM30_{t-1} + \beta_{23} \pi^h_{t-1} + u_{it}
\end{aligned} \tag{9}
$$

Next,I draw random variables of e_{it} and u_{it} and simulate interest rates and house price inflation based on their values at the time of contract closing for each loan, so loans that closed at the same time will have the same simulated path of states.

The stochastic process of unemployment rate is modeled as an ARIMA(1,1,0) process for each county[28], and forecast the unemployment rate. The CPI and 15-year fixed mortgage rate are estimated using a VAR with two lags[29]. The simulated loan performances are shown in Figure 3, which is very close to the default rate based on the original data.

Parameter results are reported in Table 8[30]. The estimation results indicate that DPA borrowers put a larger weight θ on the non-housing consumption, as a result, when income decreases, they are more likely to default to maintain the non-housing consumption. As the elasticity of substitution between non-housing consumption and housing services is $\epsilon = \frac{1}{1-\tau}$, a lower elasticity (a smaller τ) makes it more costly to sustain a suboptimal ratio of non-housing and housing consumption. Consequently, borrowers are more likely to default when trigger event occurs in order to adjust the level of two consumptions. As DPA borrowers have a smaller estimated τ value, combined with a larger utility weight on non-housing consumption, the dynamic model estimation shows that DPA borrowers are riskier than non-DPA borrowers. Holding everything else constant, a decrease of income or property value increases DPA loans' probability of default more than non-DPA loans. So DPA borrowers are riskier than non-DPA borrowers, both because their relative utility of non-housing goods compared to housing goods is higher, and the elasticity of substitution between these two consumptions is lower, so their cost of having a low $\frac{\text{non-housing consumption}}{\text{housing consumption}}$ ratio is higher than non-DPA borrowers. As a result, if the property value or income drops, they are more likely to default. Moreover, as DPA Loan borrowers have a slightly lower weight of non-housing consumption, and much lower elasticity of substitution compared with Grant borrowers, this explains why we find that the DPA Loan borrowers are the most likely to default among all borrowers.

The above findings provide a policy suggestion of improving DPA loans' performance. As default risk is found to be negatively correlated with FICO scores, a minimum credit score requirement on DPA borrowers can reduce the adverse selection of riskier borrowers into DPA programs[31]. On the other hand, the DPA program characteristics such as monthly payment and LTV ratio are also found to increase the probability of loan defaults, therefore, another policy is to reduce the monthly payment of DPA borrowers. This could be done by imposing a maximum frontend

[28]This model is chosen based on the findings in Montgomery et al.(1998).

[29]The number of lags is chosen by minimizing the forecast error. These estimation results available upon request.

[30]I use the parameter of bequest motive from results of Bajari et al(2010) instead of estimating it as the three parameter system is highly unstable. The estimated γ is close to the value I use when I do include three variables in the estimation.

[31]This policy was adopted by OHFA from October 2009 to October 2010 where DPA borrowers are required to have a FICO score higher than 620.

(monthly housing expenditure/income) and backend (monthly debt/income) ratio.

In order to compare the effects of the above two policies, I apply the estimated coefficients from the previous section. I assume two different policies. The first policy imposes a minimum FICO score requirement of 620. The alternative policy imposes a maximum frontend ratio of 26% and a maximum backend ratio of 36% on Grant borrowers. The results are shown in Table 9. The first column is the predicted conditional hazard of default without any restrictions on the borrowers, the second is the conditional hazard by forcing Grant borrowers to down size their house and take no assistances, the third column is with the minimum FICO score restriction and the last is with the maximum debt ratio restriction. As shown in Table 9, both FICO score and frontend ratio restrictions reduce the probability of defaults. For example, conditioned on the loan having survived for 1 year, the hazard of default decreases by 23% and 13% respectively for the policy of miminum FICO score and maximum debt ratio. Especially for the policy of minimum FICO score restriction, its effect is almost the same as forcing Grant borrowers to down size their houses and not to take the DPA. However 1490 Grant borrowers in the original sample would not be qualified to take the Grant any more, and they might not be able to become home owners if they are wealth constrained. Instead, under a policy of minimum debt ratio, a low credit DPA Grant borrower will only need to down size their house value by 10% in order to be qualified, so most of them can still become home owners[32].

To conclude, because both the adverse selection and DPA program characteristics increase the default risk of DPA loans, both a minimum credit score requirement and a maximum debt ratio requirement can reduce the default risk of DPA loan. While a minimum credit score is more effective at reducing the probability of default, it deprives some borrowers' opportunity of becoming home owners. As a result, a maximum debt ratio policy might be better considering that the purpose of these assistance program is to help low income families achieve the home ownership.

8 Conclusion

Loans with down payment assistance are often found to have a higher risk of default than loans without. This could be caused by the adverse selection of risky borrowers into DPA programs, and it can also be caused by the program characteristics such as higher monthly payments and lower equity ratios that make borrowers more prone to default. The identification of the higher default risk is important as it provides policy suggestion on how to design DPA program to improve loan performance.

Characteristics of borrowers differ among loans without DPA and loans with either form of the DPA. The estimation results of the DPA choices show that the probability of using a DPA increases when borrowers are more wealth constrained, have a larger incentive to smooth the consumption,

[32] Assuming a household with a credit score of 600 wants to purchase a house of $ 90,000. The loan has a LTV ratio of 99%, and the closing cost is 4% of the loan amount. With a DPA Grant, this household would only need to pay 864 dollar upfront. If this household has only $1000 saving, they can only afford a house of $25,000 without the DPA Grant. However, if a policy of maximum debt ratio is imposed, this household will only need to down size the house by 10% and still get the Grant, therefore, it is still possible for them to become home owners.

or the relative cost of using DPA is lower.

The survival time estimation of loans for each DPA and non-DPA groups shows that both borrowers' characteristics and loan characteristics affect the probability of default. Specifically, an increase of income and age reduce the probability of default. A higher credit score also significantly reduces the probability of default. The option value of loans, which measures how much is the mortgage under water, has a significant effect on loan default. A 1% drop of the option value increases the expected duration of loan by 0.028%, 0.003% and 0.03% respectively for non-DPA, Grant and Loan groups. The equity share has a siginificant positive effect on non-DPA loans' expected survival time. This effect is positive but not significant on DPA loans.

The predicted rate of default and the simulated rate of default show that terms of the mortgage affect loan performances. Specifically, with the same income and interest rate path, a borrower is more likely to default when he takes a DPA which requires a higher monthly payment. The increment of monthly payment is smaller if a non-DPA borrower switches to the DPA Loan instead of the Grant, but the lower equity share by taking the Loan offsets the effect of lower monthly payment, therefore the predicted rates of default for simulated DPA choices are similar between Grant and Loan. Thus the program characteristics are not the reason for the higher default risk of the DPA Loan compared with the DPA Grant.

Parameter estimation of the dynamic model indicates the existence of adverse selection of borrowers into DPA loans. Borrowers of DPA loans are more likely to default because their relative utility of non-housing consumption is higher than housing consumption and their elasticity of substitution between these two consumptions are lower than non-DPA borrowers. As a result, a trigger event such as a decrease of income or property value (which could be due to a decrease of interest rate or house price) will more likely to cause DPA borrowers to default. Moreover, because borrowers who select into DPA Loans have the highest risk, this explains why DPA Loan mortgages have the highest probability of default.

Combined the results from the two steps, the conclusion is that both adverse selection and DPA program characteristics cause a higher default risk of DPA loans compared with non-DPA loans. A policy implication is that: imposing a minimum credit score requirement on DPA borrowers can effectively improve the loan performances, as it reduced the adverse selection problem. However, this policy also reduces the effectiveness of the assistance program on helping low income households to achieve homeownership. Another policy is to impose a lower monthly debt ratio requirement. By doing this, DPA borrowers will have to down size the houses their want to purchase to reduce the monthly payment, which reduces the probability of default.

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Table 1: Comparison of Payment Flow for Different DPA Choices

	No DPA	Grant	Loan
Property Value	100,000	100,000	100,000
LTV (excluding DPA)	90%	90%	90%
interest rate_1st	5%	5.50%	5%
interest rate_2nd	NA	NA	5.50%
DPA amount	0	3000	3000
Monthly Payment	483.14	511.01	507.65
Down Payment	10000	7000	7000
New LTV	90%	90%	93%
Initial Equity	10%	10%	7%
Based on a $ 100,000 property.			

Table 2: Total Number of Loans by DPA and Closing Year

	All	Non-DPA		DPA_Grant		DPA_2nd	
year	number	percentage	number	number	percentage	number	percentage
2005	3517	2179	0.62	1068	0.304	270	0.077
2006	8402	5610	0.668	1744	0.208	1048	0.125
2007	7216	4920	0.682	1091	0.151	1205	0.167
2008	6208	2835	0.446	1423	0.229	1950	0.314

Table 3: Descriptive Statistics

		non-DPA	DPA_all	DPA_Grant	DPA_2nd
Monthly Income	2005	3142.545	3284.959	3248.359	3433.471
		(19.836)	(26.715)	(29.601)	(61.137)
	2006	3239.976	3208.566	3140.494	3324.814
		(12.549)	(18.442)	(22.956)	(30.576)
	2007	3244.951	3180.940	3078.259	3274.746
		(13.544)	(21.019)	(30.648)	(28.611)
	2008	3312.133	3373.617	3309.529	3421.998
		(18.081)	(17.547)	(26.456)	(23.381)
Age	2005	31.839	32.165	31.955	33.015
		(0.219)	(0.281)	(0.311)	(0.655)
	2006	31.227	31.590	31.169	32.300
		(0.134)	(0.188)	(0.228)	(0.323)
	2007	31.346	32.302	31.987	32.590
		(0.145)	(0.224)	(0.321)	(0.312)
	2008	31.497	31.509	31.382	31.604
		(0.196)	(0.178)	(0.271)	(0.237)
LTV	2005	0.978	0.988	0.988	0.989
		(0.001)	(0.001)	(0.001)	(0.001)
	2006	0.969	0.990	0.991	0.990
		(0.001)	(0.000)	(0.001)	(0.001)
	2007	0.979	0.992	0.994	0.990
		(0.001)	(0.000)	(0.001)	(0.001)
	2008	0.954	0.982	0.982	0.981
		(0.002)	(0.001)	(0.001)	(0.001)
Black	2005	0.097	0.119	0.119	0.115
		(0.006)	(0.009)	(0.010)	(0.020)
	2006	0.085	0.106	0.095	0.125
		(0.004)	(0.006)	(0.007)	(0.010)
	2007	0.078	0.113	0.103	0.122
		(0.004)	(0.007)	(0.009)	(0.010)
	2008	0.082	0.110	0.111	0.109
		(0.005)	(0.006)	(0.008)	(0.007)
Hispanic	2005	0.024	0.019	0.022	0.008
		(0.003)	(0.004)	(0.004)	(0.005)
	2006	0.018	0.017	0.020	0.012
		(0.002)	(0.002)	(0.003)	(0.003)
	2007	0.019	0.021	0.021	0.021
		(0.002)	(0.003)	(0.004)	(0.004)
	2008	0.017	0.017	0.018	0.017
		(0.002)	(0.002)	(0.004)	(0.003)
FICO	2005	688.046	663.925	664.172	662.927
		(1.420)	(1.734)	(1.915)	(4.068)
	2006	696.421	665.738	670.557	657.362
		(0.868)	(1.246)	(1.540)	(2.090)
	2007	692.085	652.303	657.483	647.570
		(0.906)	(1.359)	(1.917)	(1.912)
	2008	698.524	673.383	673.512	673.285
		(1.271)	(1.111)	(1.631)	(1.512)

continued on the next page.

Table 3: Descriptive Statistics(Continued)

		non-DPA	DPA_all	DPA_Grant	DPA_2nd
Mortgage Rate	2005	0.050	0.053	0.054	0.050
		(0.000)	(0.000)	(0.000)	(0.000)
	2006	0.058	0.060	0.061	0.058
		(0.000)	(0.000)	(0.000)	(0.000)
	2007	0.061	0.063	0.065	0.061
		(0.000)	(0.000)	(0.000)	(0.000)
	2008	0.058	0.061	0.064	0.059
		(0.000)	(0.000)	(0.000)	(0.000)
Value (in $1000 unit)	2005	111.196	105.764	104.398	111.310
		(0.628)	(0.815)	(0.909)	(1.800)
	2006	115.506	101.790	99.726	105.375
		(0.434)	(0.593)	(0.755)	(0.947)
	2007	111.126	98.267	94.302	101.888
		(0.464)	(0.667)	(0.942)	(0.930)
	2008	111.024	102.504	98.334	105.652
		(0.661)	(0.579)	(0.857)	(0.777)
Loan Amount	2005	106.648	102.721	101.377	108.175
(in $1000 unit)		(0.618)	(0.810)	(0.905)	(1.773)
	2006	109.120	98.335	96.217	102.013
		(0.423)	(0.583)	(0.739)	(0.942)
	2007	105.493	94.575	90.955	97.882
		(0.456)	(0.662)	(0.929)	(0.931)
	2008	101.905	97.496	93.258	100.695
		(0.636)	(0.568)	(0.850)	(0.755)
Monthly Debt	2005	1195.444	1247.924	1223.585	1346.682
		(8.761)	(11.879)	(12.933)	(28.490)
	2006	1275.708	1255.579	1240.371	1281.946
		(5.743)	(8.212)	(10.532)	(13.032)
	2007	1318.760	1261.420	1240.838	1280.223
		(6.243)	(9.774)	(14.171)	(13.480)
	2008	1266.046	1324.187	1299.396	1342.902
		(8.398)	(7.994)	(12.131)	(10.610)
Monthly House	2005	812.804	804.396	794.091	846.213
Expenditure		(4.525)	(6.134)	(6.815)	(13.783)
	2006	885.039	820.654	803.734	849.919
		(3.273)	(4.633)	(5.929)	(7.327)
	2007	928.129	844.310	825.181	861.787
		(3.844)	(5.575)	(7.938)	(7.792)
	2008	881.033	866.225	849.447	878.890
		(5.124)	(4.699)	(7.217)	(6.175)

continued on the next page.

Table 3: Descriptive Statistics(Continued)

		non-DPA	DPA_all	DPA_Grant	DPA_2nd
Default	2005	0.108	0.148	0.136	0.192
		(0.007)	(0.010)	(0.011)	(0.024)
	2006	0.091	0.148	0.135	0.171
		(0.004)	(0.007)	(0.008)	(0.012)
	2007	0.069	0.139	0.128	0.150
		(0.004)	(0.007)	(0.010)	(0.010)
	2008	0.032	0.050	0.044	0.054
		(0.003)	(0.004)	(0.006)	(0.005)
Delinquency	2005	0.222	0.309	0.304	0.327
		(0.009)	(0.013)	(0.014)	(0.029)
	2006	0.192	0.318	0.300	0.349
		(0.005)	(0.009)	(0.011)	(0.015)
	2007	0.163	0.293	0.276	0.308
		(0.005)	(0.010)	(0.014)	(0.014)
	2008	0.084	0.145	0.139	0.150
		(0.005)	(0.006)	(0.009)	(0.008)
HH Size	2005	2.022	2.157	2.168	2.115
		(0.032)	(0.033)	(0.038)	(0.072)
	2006	1.914	2.126	2.101	2.168
		(0.017)	(0.026)	(0.033)	(0.040)
	2007	1.840	2.157	2.116	2.194
		(0.016)	(0.032)	(0.037)	(0.051)
	2008	1.817	2.019	2.022	2.017
		(0.021)	(0.021)	(0.031)	(0.027)
Income/HH Size	2005	2034.051	1981.716	1946.996	2119.053
		(22.834)	(29.709)	(32.237)	(73.121)
	2006	2222.953	1987.777	1972.617	2014.799
		(15.081)	(20.371)	(25.659)	(33.559)
	2007	2269.810	1935.862	1900.697	1967.700
		(16.187)	(22.701)	(33.075)	(31.197)
	2008	2364.627	2178.048	2117.540	2222.202
		(22.346)	(19.934)	(30.180)	(26.493)
MSA	2005	0.885	0.839	0.825	0.893
		(0.007)	(0.010)	(0.012)	(0.019)
	2006	0.874	0.798	0.754	0.871
		(0.004)	(0.008)	(0.010)	(0.010)
	2007	0.880	0.804	0.723	0.877
		(0.005)	(0.008)	(0.014)	(0.009)
	2008	0.893	0.877	0.852	0.895
		(0.006)	(0.006)	(0.009)	(0.007)
	N	15544	9799	5328	4473

Table 4: Multinomial Logit Estimation of DPA Choices

The Baseline Model is non-DPA		
VARIABLES	Grant	Loan
log(income)	0.252***	0.288***
	(0.0667)	(0.0776)
HH size	0.0303**	0.0234
	(0.0139)	(0.0158)
NH debt ratio	0.683***	0.934***
	(0.178)	(0.192)
Δunemploy	0.118***	-0.187***
	(0.0305)	(0.0375)
age	0.00174	0.00602***
	(0.00176)	(0.00197)
black	0.0691	-0.0549
	(0.0600)	(0.0663)
Hispanic	-0.160	-0.252*
	(0.126)	(0.153)
Property Value	-0.0101***	-0.00560***
	(0.000716)	(0.000791)
LTV	8.691***	7.745***
	(0.748)	(0.764)
House Price Inflation	12.60***	9.586***
	(2.088)	(2.425)
House Price Level	-0.0721***	-0.00547
	(0.00975)	(0.0124)
i-FRM30	-29.19***	23.18***
	(6.715)	(7.560)
FRM15	-0.0340	0.438***
	(0.0982)	(0.117)
620<FICO$\leq$680	-0.103**	-0.196***
	(0.0494)	(0.0549)
680<FICO$\leq$740	-0.435***	-0.288***
	(0.0549)	(0.0604)
FICO>740	-0.622***	-0.613***
	(0.0598)	(0.0680)
Loan type_2	-1.989***	-1.970***
	(0.138)	(0.129)
Loan type_3	-1.766***	-2.425***
	(0.317)	(0.330)
Loan type_6	-0.896***	-2.096***
	(0.0428)	(0.0507)
Loan type_9	-1.932***	-4.451***
	(0.212)	(0.716)
Constant	-11.02***	-20.22***
	(2.280)	(2.687)
Standard errors in parentheses		
*** p<0.01, ** p<0.05, * p<0.1		

Table 5: Loan Survival Time Estimation

VARIABLES	non-DPA	Grant	Loan
$ln(income)$	0.613***	0.614***	0.396***
	(0.0859)	(0.131)	(0.140)
NH_debt	-2.94e-05	-7.36e-05	-6.35e-05
	(6.21e-05)	(9.54e-05)	(9.55e-05)
$ln(value)$	-0.0486	-0.0680	0.142
	(0.178)	(0.274)	(0.302)
620<FICO≤680	0.480***	0.294***	0.600***
	(0.0514)	(0.0722)	(0.0872)
680<FICO≤740	0.955***	0.838***	1.061***
	(0.0709)	(0.117)	(0.134)
FICO>740	1.425***	1.088***	1.373***
	(0.0993)	(0.158)	(0.203)
HH size	-0.0584***	-0.0803***	-0.0959***
	(0.0156)	(0.0244)	(0.0254)
black	-0.0675	0.121	-0.178**
	(0.0618)	(0.0974)	(0.0891)
Hispanics	-0.0336	-0.274	-0.0158
	(0.119)	(0.176)	(0.248)
equity	1.917***	1.407	0.932
	(0.686)	(1.542)	(1.706)
option	-0.608**	-1.350***	-1.199**
	(0.263)	(0.432)	(0.499)
house expenditure	-0.000378*	-0.000501	-0.000410
	(0.000216)	(0.000364)	(0.000371)
Rent	-0.000887*	-0.000392	-0.000169
	(0.000483)	(0.000694)	(0.000840)
MSA	0.172**	0.128	0.260**
	(0.0728)	(0.0928)	(0.121)
25<age≤30	0.289***	0.458***	0.405***
	(0.0650)	(0.103)	(0.113)
30<age≤40	0.339***	0.374***	0.422***
	(0.0680)	(0.101)	(0.114)
age>40	0.204***	0.242**	0.337***
	(0.0687)	(0.101)	(0.113)
unemployment rate	-0.0490***	-0.0124	0.0167
	(0.0126)	(0.0184)	(0.0203)
Loan type_2	0.232**	-0.241	-0.0892
	(0.115)	(0.232)	(0.185)
Loan type_3	0.0893	7.389	-0.187
	(0.194)	(303.0)	(0.758)
Loan type_6	0.0450	-0.0156	0.0551
	(0.0474)	(0.0692)	(0.0974)
Loan type_9	-0.532	-0.350	7.241
	(0.403)	(0.540)	(248.9)
Rural loan	0.485	0.339	-0.661**
	(0.366)	(0.348)	(0.326)
Constant	0.858	0.813	-0.683
	(1.887)	(2.875)	(3.215)
$ln(\gamma)$	-0.513***	-0.443***	-0.470***
	(0.0399)	(0.0685)	(0.0688)
Observations	164122	54573	37202

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 6: Data and Model Predicted Default Rates

Duration	non-DPA		Grant		Loan	
	Data	Prediction	Data	Prediction	Data	Prediction
6	0.003	0.003	0.006	0.005	0.008	0.007
12	0.005	0.006	0.009	0.01	0.011	0.014
18	0.007	0.008	0.009	0.012	0.018	0.017
24	0.01	0.009	0.014	0.013	0.017	0.019
30	0.01	0.01	0.016	0.014	0.023	0.019
36	0.011	0.011	0.016	0.014	0.018	0.018
42	0.011	0.011	0.014	0.014	0.02	0.018
48	0.012	0.012	0.013	0.014	0.01	0.017
54	0.005	0.013	0.007	0.014	0	0.016
60		0.014		0.017		

Table 7: Predicted and Simulated Rate of Default

	non-DPA			Grant			Loan		
Duration	Original	Grant	Loan	non-DPA	Original	Loan	non-DPA	Grant	Original
6	0.003	0.003	0.003	0.004	0.005	0.005	0.006	0.007	0.007
12	0.006	0.006	0.006	0.007	0.01	0.009	0.012	0.014	0.014
18	0.008	0.008	0.008	0.009	0.012	0.011	0.014	0.017	0.017
24	0.009	0.01	0.009	0.01	0.013	0.013	0.017	0.019	0.019
30	0.01	0.011	0.01	0.011	0.014	0.013	0.017	0.019	0.019
36	0.011	0.011	0.011	0.011	0.014	0.014	0.016	0.019	0.018
42	0.011	0.012	0.012	0.011	0.014	0.014	0.016	0.018	0.018
48	0.012	0.013	0.013	0.011	0.014	0.014	0.015	0.017	0.017
54	0.013	0.014	0.014	0.011	0.014	0.014	0.014	0.016	0.016
60	0.014	0.015	0.015	0.014	0.017	0.016			
N	64122			54573			37202		

Table 8: Parameters of The Dynamic Model

Parameters	non-DPA	Grant	Loan
θ	0.693	0.86	0.8277
τ	0.2192	0.18	0.108
γ		2.56	
β		0.97	

Table 9: Policy Effects Based on Grant Borrowers

Duration	Grant	No Grant	FICO Limit	Debt Limit
6	0.005	0.004	0.0038	0.0043
12	0.01	0.007	0.0077	0.0087
18	0.012	0.009	0.009	0.0105
24	0.013	0.01	0.01	0.0118
30	0.014	0.011	0.011	0.0124
36	0.014	0.011	0.0117	0.0127
42	0.014	0.011	0.0116	0.0127
48	0.014	0.011	0.0117	0.0129
54	0.014	0.011	0.0114	0.013
60	0.017	0.014	0.012	0.015

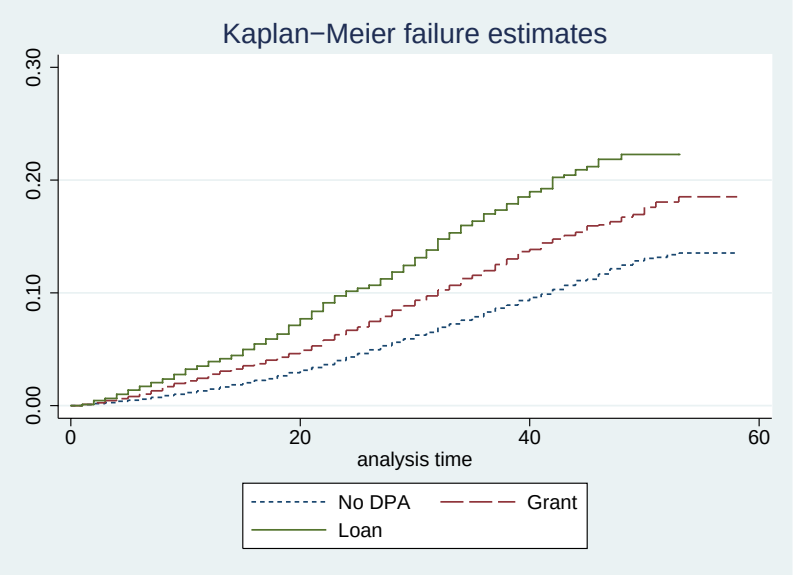

Figure 1: Kaplan-Meier Hazard of Default by DPA Choice

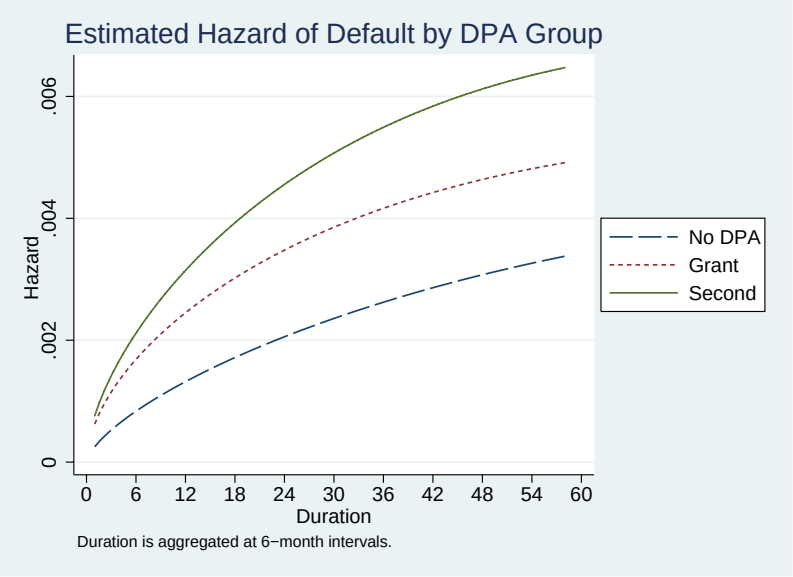

Figure 2: Conditional Hazard of Default by DPA

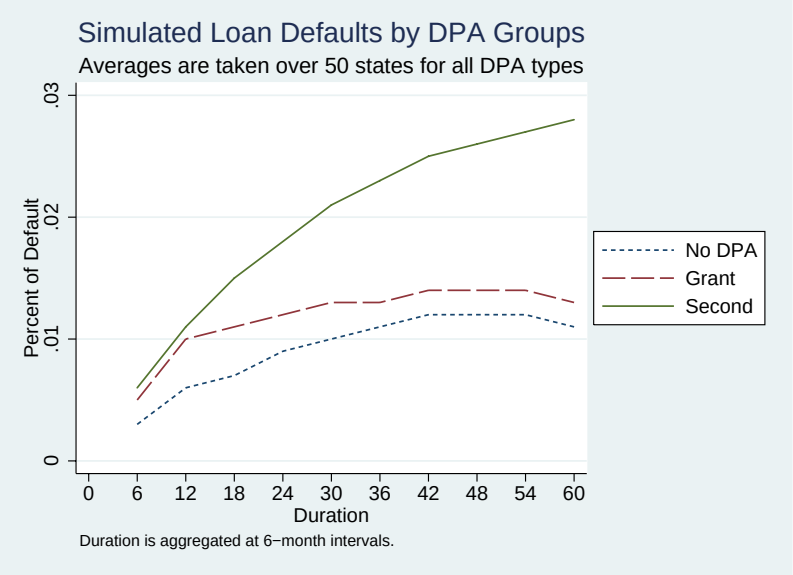

Figure 3: Conditional Hazard of Default from 50 Simulated States by DPA

Appendix A

Table A-1: Comparison of 30-year Fixed Mortgage Rate between Conventional And MRB Loans

Year	Month	FRM30	MRB rate	Year	Month	FRM30	MRB rate
2005	1	5.71	0.051	2008	1	5.76	0.061
2005	2	5.63	0.051	2008	2	5.92	0.055
2005	3	5.93	0.051	2008	3	5.97	0.054
2005	4	5.86	0.05	2008	4	5.92	0.055
2005	5	5.72	0.05	2008	5	6.04	0.057
2005	6	5.58	0.05	2008	6	6.32	0.058
2005	7	5.7	0.05	2008	7	6.43	0.059
2005	8	5.82	0.05	2008	8	6.48	0.06
2005	9	5.77	0.05	2008	9	6.04	0.061
2005	10	6.07	0.05	2008	10	6.2	0.06
2005	11	6.33	0.051	2008	11	6.09	0.064
2005	12	6.27	0.053	2008	12	5.29	0.067
2006	1	6.15	0.053	2009	1	5.05	0.069
2006	2	6.25	0.053	2009	2	5.13	0.063
2006	3	6.32	0.053	2009	3	5	0.058
2006	4	6.51	0.054	2009	4	4.81	0.056
2006	5	6.6	0.055	2009	5	4.86	0.055
2006	6	6.68	0.057	2009	6	5.42	0.055
2006	7	6.76	0.059	2009	7	5.22	0.054
2006	8	6.52	0.06	2009	8	5.19	0.054
2006	9	6.4	0.061	2009	9	5.06	0.054
2006	10	6.36	0.061	2009	10	4.95	0.054
2006	11	6.24	0.06				
2006	12	6.14	0.059				
2007	1	6.22	0.058				
2007	2	6.29	0.058				
2007	3	6.16	0.059				
2007	4	6.18	0.06				
2007	5	6.26	0.06				
2007	6	6.66	0.06				
2007	7	6.7	0.062				
2007	8	6.57	0.063				
2007	9	6.38	0.064				
2007	10	6.38	0.063				
2007	11	6.21	0.062				
2007	12	6.1	0.062				

Table A-2: Hedonic House Price Index Estimation

VARIABLES		VARIABLES		VARIABLES	
<10 acres	-6.311	1980-1989	0.314	20-49 family	-6.149
	-825.6		-825.6		-825.6
≥ 10 acres	-5.862	1990-1994	0.228	50+ family	-6.133
	-825.6		-825.6		-825.6
No kitchen_1	-0.0923***	1995-1999	0.0996	MSA10420	0.254***
	-0.0159		2000-2004		-0.00366
		>2005	0.0203	MSA15940	0.138***
			-825.6		-0.00437
# of rooms	0.127***	mobile	-1.457***	MSA17140	0.255***
	-0.00077		-0.0067		-0.00272
# of bedrooms	0.0744***	other	-6.754	MSA17460	0.321***
	-0.00145		-825.6		-0.00238
		1-family d	0.0653***	MSA18140	0.233***
			-0.00571		-0.00286
Complete plumbing_20	0.218***			MSA19380	0.159***
	-0.0148				-0.00325
built<1939	0.803	2-family	-6.296	MSA30620	0.00129
	-825.6		-825.6		-0.00623
1940-1949	0.746	3-4 family	-6.204	MSA31900	0.0195***
	-825.6		-825.6		-0.00753
1950-1959	0.672	5-7 family	-6.378	MSA45780	0.110***
	-825.6		-825.6		-0.00371
1960-1969	0.531	10-19 family	-6.522	MSA49660	-0.0221***
	-825.6		-825.6		-0.0037
1970-1979	0.373			Constant	15.97***
	-825.6				-0.00429
Observations	412561				
R-squared	0.803				
Standard errors in parentheses					
*** p<0.01, ** p<0.05, * p<0.1					

Table A-3: Total Number of Loans by DPA and Duration

	non-DPA	Grant	Loan
6	534	887	487
12	378	409	194
18	2021	1116	1425
24	1674	427	695
30	3056	650	669
36	1970	579	444
42	3258	927	567
48	1774	596	262
54	1175	587	142
60	220	145	

Table A-4: Elasticity of Multinomial Logit Regression

	logitmfx1	logitmfx2	logitmfx3
NH_Debt	-0.032	0.112	0.106
HH Income	-0.023	-0.027	0.150
Δunemploy	0.001	-0.011	0.002
FICO	0.511	-1.606	-1.836
age	-0.024	-0.053	0.172
HH size	-0.012	0.071	0.021
black	0.001	0.005	-0.007
Hispanics	0.001	-0.002	-0.004
Mortgage Amount	0.136	-0.482	-0.452
LTV	-1.836	5.595	6.715
$\Pi_H PI$	-2.661	17.705	3.436
HPI	-2.062	21.687	-2.565
FRM30-FRM15	-0.359	4.710	-1.057
Interest Rate	-4.469	42.851	-2.837

Table A-5: Elasticities of Loglogistic Model Coefficients

_t			
loginc	4.921	4.922	3.192
nh_debt	-0.011	-0.032	-0.028
logval	-0.564	-0.779	1.634
fico=1	0.142	0.111	0.205
fico=2	0.274	0.194	0.261
fico=3	0.409	0.172	0.189
hhsize	-0.111	-0.169	-0.202
black	-0.006	0.013	-0.021
hispanic	-0.001	-0.006	0
equity	0.14	0.082	0.023
option	0.028	0.003	-0.035
monthlyhouse	-0.332	-0.403	-0.354
fmr	-0.582	-0.248	-0.112
msa	0.152	0.1	0.23
agecohort=1	0.104	0.15	0.13
agecohort=2	0.104	0.12	0.136
agecohort=3	0.044	0.053	0.083
unemploy_m	-0.342	-0.089	0.121
lotype=2	0.008	-0.003	-0.002
lotype=3	0.005	0.019	0
lotype=6	0.029	-0.007	0.015
lotype=9	-0.007	-0.002	0.004
mi_rural	0.009	0.007	-0.004
Constant			

Table A-6: Statistics for The 10% Random Sample

variable	year	mean	variable	year	mean	variable	year	mean
income	2005	3207.37	credit	2005	671.25	House Expend	2005	808.18
		(49.82)			(3.52)			(11.36)
	2006	3256.55		2006	684.88		2006	868.83
		(32.45)			(2.27)			(8.00)
	2007	3209.29		2007	677.78		2007	894.51
		(37.03)			(2.52)			(10.63)
	2008	3346.90		2008	682.36		2008	880.50
		(38.60)			(2.72)			(11.11)
age	2005	31.60	interest rate	2005	0.05	default	2005	0.11
		(0.53)			0.00			(0.02)
	2006	30.88		2006	0.06		2006	0.10
		(0.31)			0.00			(0.01)
	2007	31.98		2007	0.06		2007	0.09
		(0.40)			0.00			(0.01)
	2008	32.08		2008	0.06		2008	0.05
		(0.43)			0.00			(0.01)
LTV	2005	0.98	Prop_Val	2005	108.36	Delinquent	2005	0.21
		(0.00)			(1.46)			(0.02)
	2006	0.98		2006	112.51		2006	0.21
		(0.00)			(1.12)			(0.01)
	2007	0.98		2007	105.77		2007	0.18
		(0.00)			(1.27)			(0.02)
	2008	0.97		2008	106.58		2008	0.13
		(0.00)			(1.41)			(0.01)
black	2005	0.13	mtg amt	2005	104.43	Grant	2005	0.28
		(0.02)			(1.44)			(0.02)
	2006	0.08		2006	106.63		2006	0.21
		(0.01)			(1.06)			(0.01)
	2007	0.11		2007	100.68		2007	0.14
		(0.01)			(1.25)			(0.01)
	2008	0.09		2008	98.88		2008	0.25
		(0.01)			(1.36)			(0.02)
Hispanic	2005	0.03	Debt	2005	1244.72	Loan	2005	0.10
		(0.01)			(25.19)			(0.02)
	2006	0.02		2006	1263.65		2006	0.12
		(0.01)			(13.28)			(0.01)
	2007	0.01		2007	1296.12		2007	0.17
		(0.00)			(17.41)			(0.02)
	2008	0.02		2008	1297.77		2008	0.31
		(0.01)			(17.56)			(0.02)
N					2681.00			

Table A-7: Estimated Coefficients of VAR

MSA	β_{11}	β_{12}	β_{13}	β_{21}	β_{22}	β_{23}	std_i	std_π	ρ
1	0.32216	0.9482	-2.02611	-0.02984	0.0053	0.2052	0.13858	0.00006	-0.00095
10420	0.51461	0.91462	0.06671	-0.03843	0.00651	0.08955	0.13878	0.00009	-0.00203
15940	0.52295	0.91304	0.40932	-0.0521	0.00864	-0.008	0.13875	0.00013	-0.00228
17140	0.52666	0.91208	0.75344	-0.02079	0.00382	0.2964	0.13875	0.00004	-0.00074
17460	0.49943	0.9174	-0.56662	-0.03529	0.00578	0.25275	0.13872	0.00009	-0.00171
18140	0.3802	0.94158	-6.58865	-0.02238	0.00406	0.27235	0.13624	0.00004	-0.00067
19380	0.51014	0.91548	-0.18081	-0.02671	0.00467	-0.00618	0.13878	0.00006	-0.0012
26580	0.51333	0.91504	-0.12696	0.00052	0.00194	-0.45936	0.13877	0.0002	-0.00087
30620	0.38531	0.93974	-5.19747	-0.03246	0.00611	-0.15578	0.13361	0.00018	0.00006
31900	0.44697	0.9267	-2.01182	-0.0552	0.00942	-0.2918	0.13726	0.00033	-0.00097
37620	0.47343	0.92536	-3.67448	-0.01922	0.00469	-0.41169	0.13491	0.00023	-0.00065
41780	0.43959	0.92772	-1.83458	-0.06857	0.0114	-0.21429	0.13756	0.00039	-0.00258
44220	0.42579	0.93082	-3.24228	-0.0344	0.00595	0.03797	0.137	0.00015	-0.00139
44600	0.50654	0.91669	-0.57637	-0.04351	0.00836	-0.39414	0.13853	0.00062	-0.0022
45780	0.4217	0.93095	-2.60153	-0.04153	0.00688	0.2025	0.13791	0.0001	-0.00087
48540	0.48011	0.91777	1.73133	-0.01243	0.00359	-0.34849	0.13614	0.00071	-0.00221
49660	0.44127	0.92881	-3.26134	-0.038	0.00652	0.01231	0.13711	0.00013	-0.00188

Appendix B

The Ohio Economic Survey was initiated by the Ohio State University Center for Survey Research in November, 1996 as a monthly telephone survey of residents of Ohio, a major test-market states whose population closely reflects the U.S. population as a whole. Random Digit Dialing was used to obtain a sample of at least 500 completed cases each month. The final dataset consists of 40,320 cases, of which 30,557 were credit card holders. These data were weighted to take into account the number of telephone lines in each household and to adjust for variations in the sample from U.S. population related to various demographic and socioeconomic factors. Respondents were encouraged to consult their most recent credit card statements in order to facilitate the recall of the credit card information. This could include terminating the phone call with scheduling a callback when the respondent had all the information. Usual survey quality standards were enforced to ensure high quality data, including third party monitoring and extensive checks for internal consistency in the responses using filtering algorithms. There are a variety of variables on credit card use in the OES, including monthly charges, cash advances, monthly payments, revolving balances, minimum required payments, credit limits, annual percentage rates, number of cards charged on, number of cards maxed out, and number of times missing minimum required payments. In addition, the OES contains consumer confidence measures, price expectations, and psychological debt stress variables, in addition to the usual socioeconomic and demographic information.

The Consumer Finance Monthly is an on-going national survey, which began in February 2005 as the OES was moved to the national level and expanded to cover more consumer debt instruments and complete asset information. At least 300 new cases have been added each month. Approximately 7,000 cases from the CFM, which covered the period to the end of 2006 are used in this research.

Table B-1 below presents key sample characteristics for the Ohio sample in the OES and the national-level samples of both the CFM and the SCF. The main difference occurs with gender. The disproportionate number of males in the SCF arises from its personal interviewing of household heads in a sample that over-represents the wealthy. The breakdowns of the OES and the CFM are closer to the actual national proportions, which results from its random sampling techniques. The closeness of sample characteristics for the OES and the CFM attests to the wide range of application of findings in this research.

Table B-1: Descriptive Statistics for the OES, 1998 SCF, and 2005 CFM

Variables	OES Mean	SCF Mean	CFM Mean
Log of household income	10.5	11.1	10.36
APR (annual percentage rate)	14.37	14.52	14.02
Ethnicity: percentage white	0.86	0.86	0.83
Homeownership: percentage owners	0.77	0.78	0.76
Education	13.19	14.32	14.54
Age	47.15	50.02	52.57
Gender: percentage males	0.41	0.76	0.43

Note: The statistics for the SCF are taken from Min and Kim (2003), Table 2.