Reverse Mortgage and the Dynamics of Senior Households' Borrowing Behavior

*Very Preliminary Version

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Abstract

Since the invention of reverse mortgage loans, it has generated debates on whether elderly borrowers can benefit from these programs. Given the complexity of the reverse mortgage and its unique risk exposure comparing to traditional forward mortgage products, it is important to examine whether reverse mortgage borrowers truly understand the loan and are able to make optimal decisions that maximize their welfare. Using data from the Home Equity Conversion Mortgage (HECM) of the United States, this paper studies the dynamic of households' borrowing behavior after they take out HECM loans. Specifically, using a life-cycle consumption model, we will examine whether and how HECM borrowers' behavior changes according to economic conditions, and whether it differs across various dimensions of borrower/loan characteristics. More importantly, we want to find out whether elderly households participating in the reverse mortgage tend to over-borrow which might do more harm to their welfare in the long term. Findings of this paper can be useful to provide better counseling service to potential reverse mortgage users, and it can also help program providers to better understand the borrower behavior and the program cost.

Introduction

Reverse mortgages allow senior homeowners to extract equity from their homes without mortgage payments. They provide a unique opportunity for elderly households who have the bulk of their wealth in the form of illiquid housing assets and limited income to access the equity while staying in the property.

Merrill, Finkel and Kutty (1994) use American Housing Survey to study the potential size of the market for unrestricted reverse mortgages. They conclude that the prime group for the unrestricted reverse mortgages is the group of homeowners aged 70 or above, with an annual income of $30,000 or less, with home equity between $100,000 and $200,000, who have lived in their homes for over ten years. The authors find the reverse mortgage payments could substantially increase the income for these homeowners. Their finding is consistent with the original purpose of reverse mortgage to help "house rich, cash poor" households. To analyze the potential of reverse mortgages to increase household income and liquid wealth, Mayer and Simon (1994) use the 1990 Survey of Income and Program Participation and Census population estimates, and find a large potential market for reverse mortgages. Their result indicates that more than 6 million homeowners in the United States could have their effective monthly income increased by at least 20 percent by using a reverse mortgage.

However, the demand of reverse mortgages was much lower that suggested by previous research until 2000s. Using loan-level reverse mortgage data, Shan (2011) shows that recent reverse mortgage borrowers are significantly different from earlier borrowers in many respects and the substantial growth of reverse mortgage market is partially explained by the increase of house price.

With development of the primary and secondary market for reverse mortgage, and better understanding of reverse mortgage products, more usage of reverse mortgage has been examined by researchers.

Studies have shown that with proper management, the reverse mortgage can be used as an asset management tool. For example, Rasmussen *et al*. (1997) provide an expansive view of reverse mortgages as a financial tool for tapping housing equity for various purposes and at different stages of life. They show that reverse mortgages can turn housing equity into personal human capital investment accounts, enabling children to provide care for their disabled parents, funding elderly households' long-term care insurance and sustaining consumption. Fratantoni (1999) uses

a simulation model to show that if the elderly are more concerned with unavoidable expenditure shocks on their standard of living, they would be better off by selecting a line-of-credit reverse mortgage plan.

On the other hand, there are studies showing that the availability of reverse mortgages could affect the usage of long-term care insurance. For instance, Davidoff (2008) shows that home equity tapped in the event of long-term care reduces the gain to insurance transfers from healthy states. He also finds empirical evidence in the Health and Retirement Study that households exposed to large increases in home equity in the recent housing boom were relatively unlikely to add long-term care insurance coverage and relatively likely to drop the coverage.

Borrowers can also use reverse mortgage for home improvement in place of a home equity loan to avoid the restriction on income level. Based on the history of reverse mortgage and American Housing Survey, Davidoff and Welke (2004) find that reverse mortgage borrowers in the US have moved out of their homes at a much faster rate than the demographically similar non-borrowers. They argue that this is because the types of people who wish to take equity out of their homes through reverse mortgage borrowing are also likely to take out the remaining home equity by selling their homes. They use a life-cycle model without extremely strong bequest motives or complementarities between non-housing and housing consumptions to explain the rapid exit from homes for reverse mortgage borrowers. The revealed preference from their model indicates that reverse mortgage borrowers are likely to have a greater gap between marginal utility before moving and marginal utility after moving than those who find reverse mortgage unattractive.

While the benefit of reverse mortgages is widely recognized, concerns have been raised that many reverse mortgage borrowers do not understand the program cost, and thus are not able to make the optimal choice among different mortgage options and may over-borrow in response to the changes of the economic condition. Issues of improper or sometimes even proprietary industry practice of mortgage brokers also bring up the question of whether reverse mortgage do more harm to senior homeowners than benefit. As a result, one important but little studied issue is how borrowers adjust their consumption and saving after they take out reverse mortgages.

The after retirement consumption and saving/dissaving behavior has been shown to be related to the uncertainty of future (Zeldes 1989). Blau (2008) finds that the majority of households maintain a smooth consumption path at the time of retirement. But these early studies of after retirement consumption patterns assume a stable household income. The usage of reverse mortgages complicates the problem since now households can utilize their illiquid housing equity

whose value depends on house price and interest rate. Using the Survey of Consumer Finance, Sinai and Souleles (2007) show that the recent increase in house prices increased the net worth of retirement-aged households, but less than one-for-one. They also find that the fraction of housing equity that is consumable increases with house price and decreases with interest rate but is still constrained and relates to the age of borrowers. Consequently, the consumption and saving behavior of reverse mortgage borrowers are expected to change with economic condition and age.

Due to the complexity of reverse mortgages and its unique risk exposure comparing with tradition mortgage product, it is important to examine whether reverse mortgage borrowers truly understand the loan and are able to make optimal decisions that maximize their welfare.

Using data from the Home Equity Conversion Mortgage, the largest reverse mortgage program in the U.S., this paper studies the dynamic of households' borrowing behavior after they take out HECM loans. Specifically, using a life-cycle model of consumption, we will examine whether and how HECM borrowers' behavior changes according to economic conditions, and whether it differs across various dimensions of borrower/loan characteristics. More importantly, we want to find out whether elderly households participating in the reverse mortgage tend to over-borrow which might do more harm to their welfare in the long term.

As the senior population of the U.S. continues to grow, the after retirement assets management has become more and more important due to its significant impact on elderly households' welfare[1]. Answers to the above questions can be useful in providing better counseling service to potential and existing reverse mortgage users. On the supply side, better understanding the borrower behavior can also help evaluate the benefit and cost of reverse mortgage programs and improve the program design.

Background of HECM Program

HECM program is a reverse mortgage program insured by the Federal Housing Administration (FHA). Since its inception, more than 768,000 reverse mortgages have been endorsed by FHA. A borrower (one of the homeowner) must be 62 years of age or older in order to be eligible for a HECM. If the senior homeowner still has a mortgage on the property, the HECM proceeds must be able to cover the remaining outstanding balance. FHA-approved reverse mortgage counseling is also required before applying HECM loans. Borrowers receive cash payments or credit lines

[1] The percentage of senior population (age 60 and above) increased from 15.7% in 2000 to 18.5% in 2011.

backed by their home. No repayment is required as long as borrowers continue to live in the property and make timely payment on the property taxes, homeowners insurance and meet the HUD guidelines regarding home maintenance. A HECM terminates when borrowers die, move out of the property, refinance to a new HECM loan or default on tax and insurance.

The initial equity available to a HECM borrower is called the principle limit, which is a fraction of the property appraisal value (capped by the FHA insurance limit). This fraction—principle limit factor (PLF)—is determined by the borrower's age and interest rate. The PLF is larger when a borrower is older or the interest rate is lower. Borrowers can choose fixed rate or adjustable rate (annual or monthly) loans, and can choose between Treasury indexed and LIBOR indexed rate. Regardless of which interest rate plan a borrower takes, the PLF will be determined by the market ten year Treasury rate at the time of loan application.

HECM program provides several payment plans: tenure, term, line of credit or the combination of line of credit and tenure or term plan. The tenure plan provides a fixed monthly cash payment as long as the borrowers stay in their home. Term plan provides a fixed monthly cash payment over a specified length of years. The line of credit allows the borrower to draw on allowable funds at any time. Borrowers can switch between different payment plans after HECM loans are originated. HECM borrowers decide how much they draw or repay each period of time after loans are originated.

FHA charges upfront premium and annual premiums for providing insurance on lenders' losses on non-repayment when loans terminate. These premiums are added into the unpaid balance (UPB) as well as the interest and service fee. If borrowers fail to make timely payment of tax and insurance, the servicer will first use the available HECM credit to pay that off, after borrowers' credit line is exhausted, servicers will follow FHA's guidelines on tax and insurance default to terminate the loan. The principle limit also increases with interest rate, so that the unused part equity in the HECM loans accrues interest as well. Borrowers can repay the UPB at any time.

In the end of 2010, a "saver" HECM program was introduced. Comparing to a standard HECM program, saver program has a lower upfront premium but the amount of equity a borrower can access is also reduced by lowering the PLF. Since it is a fairly new program and the pick-up rate

for the saver option is relatively low, we do not have enough observation on loan performance. Therefore, we exclude saver loans in this study2.

Model

A life-cycle choice model is used to analyze the optimal borrowing behavior of a representative HECM borrower. The model does not seek a close form solution, but rather use the first order condition to obtain insight of the borrowing behavior of HECM borrowers. Comparing with the results from the empirical testing, I will be able to answer the two questions from the previous section.

We first consider a model where a HECM borrower has no bequest motives and no other saving beside housing equity. He/she derives utility from housing and non-housing consumption. The borrower's initial wealth is W_0 which is the value of the property. The utility this borrower obtain from the housing stock of H_0 is $g(H_0)$. This utility level stays constant for the duration of the HECM loan since HECM loans terminate if borrowers move[3]. The non-housing consumption for the borrower is C_t, and he earns a constant income of Y. We assume that a borrower uses all the cash draw from the HECM loan for the consumption purpose. The conditional probability of stay alive at time t is ϑ_t, and the discount rate is β. The probability of death at time T+1 is 1.

The HECM borrower's goal at time t is to:

$$\text{Max} \sum_{n=t}^{T} \beta^{T-t} \vartheta^{T-t} E_t u(C_t, g(H_0)) \quad (1)$$

subject to the dynamic budget constraint:

$$W_{t+1} = (W_t - C_t) * R_{t+1} + Y \quad (2)$$

Since housing stock remain constant overtime, it can be normalized to 1, so that $g(H_0)$ can be dropped to simplify the model and non-consumption is a relative measure to housing consumption.

[2] In 2013, FHA consolidates the fix-rate HECM loans with the saver option, so that borrowers can only choose saver program if they select fix-rate loan (HEMC Mortgagee Letter 2013-01).

[3] Here I assume that the housing stock remain constant even when a borrower uses the cash draw for home improvement to make the result tractable. As a result, the extra utility one gains from home improvement is not differentiable from non-housing consumption.

For a non-HECM household, R_t will be the rate of return on the saving, which usually is the risk-free rate. For HECM borrowers, the rate of return depends on the house price appreciation rate because HECM borrowers can refinance into a new HECM to tap into the increased equity[4]. It also depends on borrowers' age and effective market interest rate, because PLF increases with age and decreases with interest rate. We denote the rate of return for a HECM borrower is $R_t(\pi, i, age)$. The rate of return increases with house price and decreases with interest rate with a lower bound of 1, because principle limit will not decrease with house price as long as they keep the same HECM loan[5].

The wealth level is expected to increase by less than one-to-one in response to house price increase for two reasons. First, borrowers will be charged a certain amount of service fee for refinancing into a new HECM loan. Second, principle limit is based on MCA, which is the minimal of property value and a maximum amount set by FHA. Therefore, if the value of a property surpasses the maximum amount covered by FHA insurance, the principle limit will increase by a smaller percentage.

The problem can be written recursively as

$$V_t(W_t) = max_{C_t} u(C_t) + \beta\vartheta E_t V_{t+1}((W_t - C_t) * R_{t+1}(\pi, i, age) + Y) \quad (3)$$

The first order condition implies that:

$$u'(C_t) = E_t\{R_{t+1}(\pi, i, age)\beta\vartheta * u'(C_{t+1})\} \quad (4)$$

Under perfect foresight assumption, and constant relative risk averse (CRRA) utility $u(c) = c^{1-\rho}/(1-\rho)$[6], the equation can be written as:

$$\frac{u\prime(C_t)}{u\prime(C_{t+1})} = R_{t+1}(\pi, i, age)\beta\vartheta \quad (5)$$

$$\left(\frac{C_t}{C_{t+1}}\right)^{-\rho} = R_{t+1}(\pi, i, age)\beta\vartheta \quad (6)$$

$$\left(\frac{C_{t+1}}{C_t}\right) = (R_{t+1}(\pi, i, age)\beta\vartheta)^{1/\rho} \quad (7)$$

Where ρ is the curvature parameter.

[4] Non-HECM households can also gain from the increased property value by selling the property, but this requires the family to move out of the house.

[5] In this way, a HECM contract is similar to an option contract, whose price is the mortgage insurance premium plus the amount difference between property value and principle limit.

[6] The CRRA utility function has been found to be a good description of microeconomic condition. For example Brunnermeier and Nagel (2008).

Comparative statics suggests that $\frac{\partial C_{t+1}}{\partial R_{t+1}} > 0$. The sign of $\frac{\partial C_t}{\partial R_{t+1}}$ depends on parameter values, especially ρ.

Departing from the perfect foresight assumption, as long as a HECM borrower's expectation is forward looking, the consumption is expected to increase with the future rate of return. Since the retirement income of a HECM borrower is assumed to be constant, or in practice unlikely to increase with $R_{t+1}(\pi, i, age)$, the borrower is expected to increase the cash draw in the future period in order to satisfy a high expenditure on consumption. Even if the increase of house price is only transitory, it will affect all future periods of consumption due to the increase of housing equity and borrowers' consumption smooth motive.

The first order condition also indicates that $\frac{\partial C_t}{\partial \vartheta_{t+1}} < 0$ and $\frac{\partial C_{t+1}}{\partial \vartheta_{t+1}} > 0$. So a borrower will increase the cash draw in the current period when he is less likely to stay alive in the next period because there is no bequest motive.

To summarize, a HECM borrower's optimal cash draw increases with house price, age of the borrower. It also increases when interest rate decreases. Since borrowers' age and mortality rate have offsetting effect on the future cash draw, economic condition would be the main driver for changes of cash draw. Borrowers could also have unforeseeable expenditure such as medical bills that requires borrowers to suddenly increase cash draw, which is not captured in this model.

We now include a bequest motive into the model, denoting the utility from bequests is v(b), then the Bellman equation is:

$$V_t(W_t) = \begin{cases} max_{C_t} u(C_t) + \beta E_t V_{t+1}(W_{t+1}) \; if \; alive \\ v(W_t) \; if \; dead \end{cases} \quad (8)$$

This optimization problem cannot be solved numerically, and the first order condition is less explicit now that a borrower can gain utility from bequest. The impact of each individual factor is difficult to predict with the inclusion of bequest motives, since it depends on how much weight is assigned to utility of bequest. Therefore, the model with bequest motives will be used only for reference purpose.

Data and Descriptive Statistics

The data is the loan-level origination and performance data of HECM programs provided by FHA. It also includes the annual cash draw amount of each loan. The complete sample includes all HECM loans endorsed by FHA from 1989 to 2011. I use mortality table from Social Security. The interest rate and house price history and projection come from Moody's Economy.com. I also use data from the Health and Retirement Study to analyze the representativeness and changes of HECM borrowers comparing to the average population.

Table 1 presents the summary statistics of HECM loans originated between 1990 and 2011. The number of HECM loans originated annually had been quite small until year 2001, and then starting from 2005, the speed of HECM demand had a significant increase and stayed high until 2009. A continuing decrease of HECM demand is observed in recent years (2010-2011). The average age of HECM borrowers slowly decreased from 76 in 1990 to 72 in 2011. The percent of HECM borrowers that are married increased until the peak of the recent housing bubble burst, and has been decreasing since then. More than 90% of HECM loans are adjustable rate loans until 2009, but over time, the share of annual adjustable rate loans is replaced by the monthly adjustable loans. It is worth mentioning that, due to investors' requirement since 2009, HECM borrowers who wanted to take the fixed rate option had to make a big cash draw (>90%) in the first month of loan origination. As a result, there could be a sample selection problem for the recent cohorts, and these HECM borrowers' cash draw behavior might be very different from the older cohorts. Among the adjustable rate loans, we also see a significant drop of Treasury indexed HECM loans due to changes in the secondary market environment. One major drive is that Fannie Mae discontinued its purchase of Treasury indexed HECM loans. As a result, lenders might purposely direct borrowers to LIBOR indexed HECM loans in order to sell it in the secondary market.

To better illustrate the changes of HECM borrowers over the years, Figure 1 presents the key variable values by origination years, and compare the HECM borrowers with HRS sample average as well.[7] From Figure 1, we can see clearly that the average property value of HECM borrowers stayed at a relatively stable level until 1998 and then started to increase until hitting the break in 2006. The average value started to increase again in 2009, but similar to the reason

[7] HRS was designed to follow age-eligible individuals and their spouses as they transit from active workers into retirement. It includes information about individuals' health, family and economic conditions. The original wave started in 1992 and then every other year afterwards. Households and individuals can be linked through id variables across waves and different weight can be applied to estimate the population parameters. For example, household level weights are post stratified to the March Current Population Survey for the year of HRS data collection. In order to be consistent with HECM borrowers, I restricted the HRS sample to be individuals that are at least 62 years old (for couples, the younger of the couple).

mentioned above, this could be a result of the increase in share of fixed rate HECM loans and a different composition of borrowers.

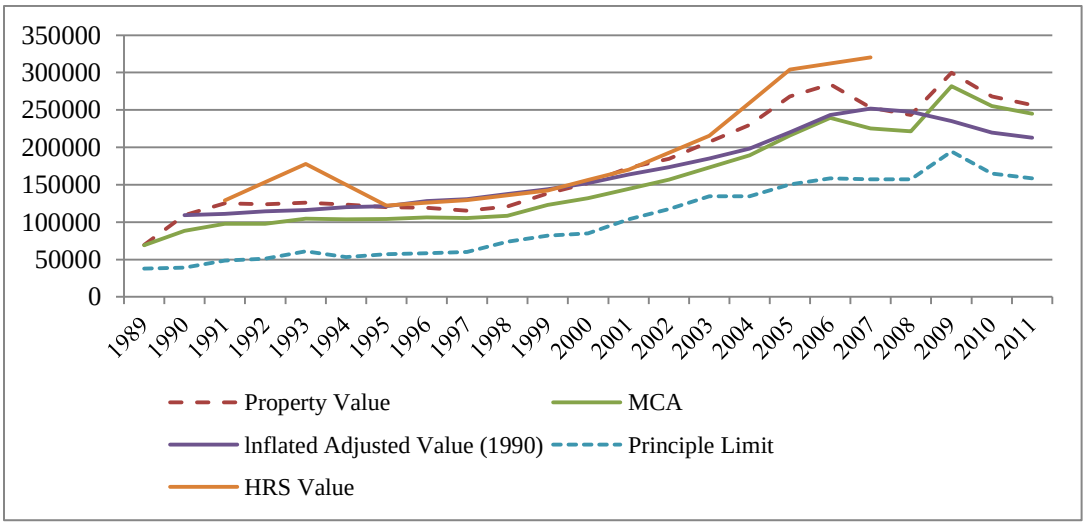
Table 1. Summary Statistics of HECM Borrowers by Origination Year

Year	#	_STAT_	Age	Property Value	MCA	Principle Limit	Rate	ARM (annual)	FRM	Married	Treasury Indexed
1990	211	MEAN	76	109,275	88,426	39,266	6.49	90.05%	9.95%	29.38%	1
		STD	7	62,840	27,234	16,941	1.71	30.01%	30.01%	45.66%	0
1991	323	MEAN	77	125,200	97,840	48,697	5.87	95.05%	4.95%	26.63%	1
		STD	7	78,076	28,248	18,958	2.01	21.73%	21.73%	44.27%	0
1992	1466	MEAN	76	123,895	97,767	51,237	5.27	99.18%	0.82%	29.40%	1
		STD	7	72,858	27,914	18,151	2.28	9.01%	9.01%	45.58%	0
1993	2874	MEAN	75	126,190	104,782	60,902	5.00	99.44%	0.49%	28.67%	1
		STD	7	75,417	36,355	23,921	2.40	7.44%	6.96%	45.23%	0
1994	4106	MEAN	75	123,427	103,618	53,298	5.36	95.88%	1.56%	30.59%	1
		STD	7	71,821	35,403	22,442	2.19	19.87%	12.39%	46.08%	0
1995	3891	MEAN	75	120,201	104,222	57,110	5.18	90.08%	0.51%	30.51%	1
		STD	7	64,437	34,071	22,568	2.15	29.90%	7.15%	46.05%	0
1996	5565	MEAN	75	119,067	106,202	58,243	4.83	58.10%	0.38%	29.97%	1
		STD	7	59,402	34,263	23,602	2.30	49.35%	6.13%	45.82%	0
1997	5848	MEAN	75	115,437	105,304	60,159	4.48	21.56%	0.84%	29.17%	1
		STD	7	55,653	35,679	23,811	2.16	41.13%	9.12%	45.46%	0
1998	6750	MEAN	75	121,071	108,621	73,752	3.84	8.10%	0.31%	30.10%	1
		STD	7	67,453	39,887	32,619	2.14	27.29%	5.57%	45.87%	0
1999	7575	MEAN	75	138,335	122,938	81,804	3.68	4.87%	0.32%	31.42%	1
		STD	7	84,080	48,702	39,341	2.04	21.53%	5.62%	46.42%	0
2000	6351	MEAN	76	152,223	132,030	84,992	3.40	3.31%	0.05%	28.97%	1
		STD	8	100,040	51,904	41,364	1.77	17.88%	2.17%	45.37%	0
2001	9937	MEAN	75	172,628	144,594	103,944	3.20	2.44%	0.05%	34.40%	1
		STD	7	116,883	57,759	49,402	1.77	15.42%	2.24%	47.51%	0
2002	13549	MEAN	74	184,685	156,874	117,563	3.36	3.36%	0.04%	34.86%	1
		STD	7	118,543	64,151	58,774	1.87	18.02%	2.10%	47.65%	0
2003	28707	MEAN	74	207,334	173,031	134,762	3.22	5.20%	0.06%	37.32%	1
		STD	7	134,043	71,886	64,703	1.96	22.21%	2.50%	48.37%	0
2004	37575	MEAN	74	230,231	189,271	134,509	3.05	3.60%	0.14%	36.14%	1
		STD	7	146,284	77,700	59,112	2.00	18.63%	3.68%	48.04%	0
2005	57846	MEAN	73	268,290	215,703	150,499	2.39	0.41%	0.08%	38.73%	1
		STD	7	164,400	83,790	60,779	1.64	6.39%	2.82%	48.71%	0
2006	88770	MEAN	73	284,443	239,253	158,432	1.94	0.19%	0.11%	37.63%	1
		STD	7	169,815	98,332	68,485	1.06	4.37%	3.29%	48.45%	0
2007	105287	MEAN	73	253,038	225,153	157,464	1.35	0.06%	0.76%	36.99%	99.65%
		STD	7	144,179	95,356	68,995	0.66	2.35%	8.70%	48.28%	5.94%
2008	114080	MEAN	72	243,418	221,261	157,321	1.80	0.24%	2.68%	35.17%	89.68%
		STD	7	155,590	100,733	73,770	0.78	4.91%	16.16%	47.75%	30.43%
2009	105621	MEAN	72	299,688	281,866	194,703	3.80	0.73%	34.35%	36.68%	32.93%

Year	#	_STAT_	Age	Property Value	MCA	Principle Limit	Rate	ARM (annual)	FRM	Married	Treasury Indexed
2010	72092	STD	8	218,901	165,411	117,619	1.36	8.49%	47.49%	48.19%	47.00%
		MEAN	72	268,067	255,344	164,780	4.50	0.03%	68.42%	36.30%	0.08%
		STD	8	211,387	165,163	109,153	1.40	1.62%	46.49%	48.09%	2.89%
2011	53775	MEAN	72	256,610	245,013	158,509	4.28	0.02%	69.58%	33.52%	0.12%
		STD	8	207,138	161,798	105,093	1.20	1.49%	46.01%	47.21%	3.41%

Aside from the cohorts after 2009, the trend of property value of HECM borrowers are quite similar to the recent boom and bust of housing cycle. Based on the 1990 average HECM property value and the national house price appreciation (HPA), the rate of increase for HECM property value surpassed the national HPA. This could be the result of more HECM loans originated in states that had above average HPA such as California and Florida during this period. However, comparing with the HRS weighted sample average, HECM borrowers tend to be households that have properties below average elderly homeowners. This is consistent with the fact that HECM borrowers are homeowners who need to tap into their equity, thus might be more financially constrained than average elderly homeowners.

Figure 1. Comparison of Key Origination Variables



The average MCA is always lower than the property value because MCA is the less of the property value and a loan limit set by FHA. Similarly, principle limit is only a portion of the property value and is affected by borrowers' age and effective interest rate at the time of loan origination. As the average borrowers' age gets younger and the interest rate decreases, these two

factors had off setting effect on the PLF, thus on the principle limit. However, since 2009, FHA had reduced the PLFs twice to compensate the increased risk of their insurance fund, which reduced the total amount of cash that a HECM borrower can draw out of the equity.

Table 2. Selected Principal Limit Factor Changes since 2009 for Standard HECMs

Borrower Age at Origination	Expected Mortgage Interest Rate	PLFs		
		2009 and Prior	2010	2011 and onward
65	5.5%	0.649	0.584	0.569
65	7.0%	0.489	0.440	0.428
65	8.5%	0.369	0.332	0.326
75	5.5%	0.732	0.659	0.636
75	7.0%	0.609	0.548	0.516
75	8.5%	0.503	0.453	0.425
85	5.5%	0.819	0.737	0.703
85	7.0%	0.738	0.664	0.606
85	8.5%	0.660	0.594	0.531

To summarize, there are changes in HECM borrower characteristics over the years. More significant changes are observed around 2000, which correlate with the housing market boom. On the other hand, some changes are caused by the program design and investors' preference. To focus more on borrowers' decision making process and ensure enough observations for each loan, I exclude the loans originated on or after 2009.

After a HECM loan is originated, borrowers decide how much cash they want to draw out of the equity each period as long as they have not exhausted their principle limit[8]. Figure 2 and 3 present patterns of cash draw for annual adjustable interest rate loans for each cohort (loans originated within a particular year). Similar trends are observed for fixed rate and monthly adjustable HECM loans. Due to the difficulty of separating closing cost from the first year cash draw, only cash draw patterns after the first year are shown.

[8] Even though there are different types of payment options such as "line of credit" and "term payment", HECM borrowers can change the payment options after loan origination, therefore, I will not differentiate borrowers based on initial payment options.

Figure 2. Cash Draw Down as Percentage of Initial Principle Limit by Policy Year (Excludes First Year) for Annual Adjustable Loans

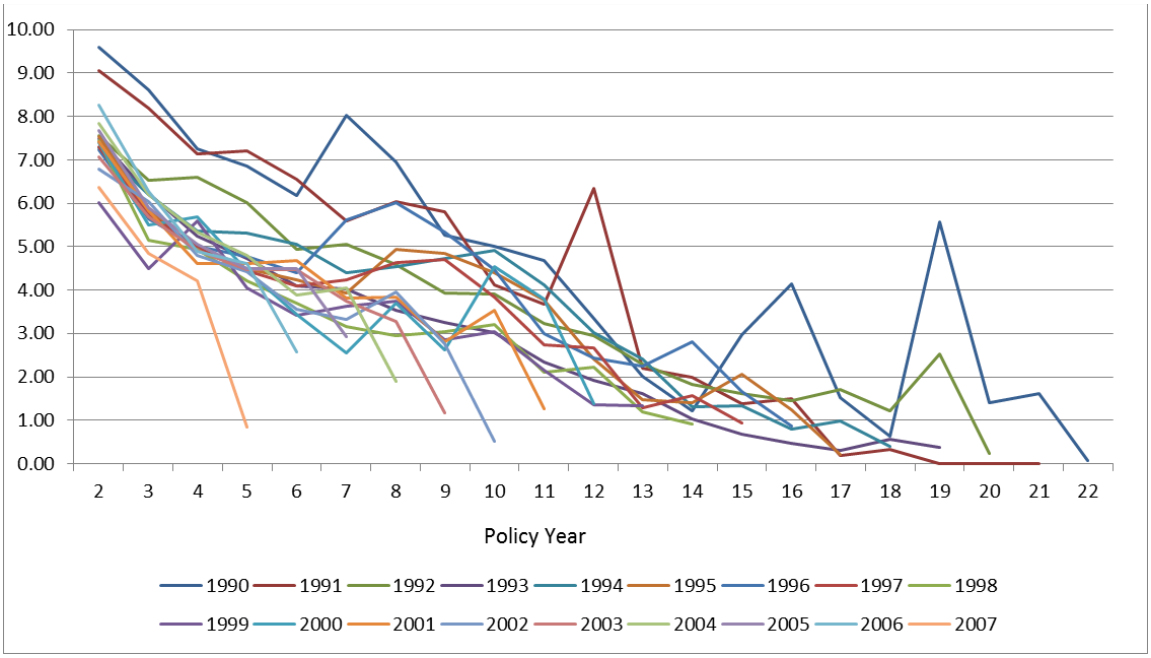
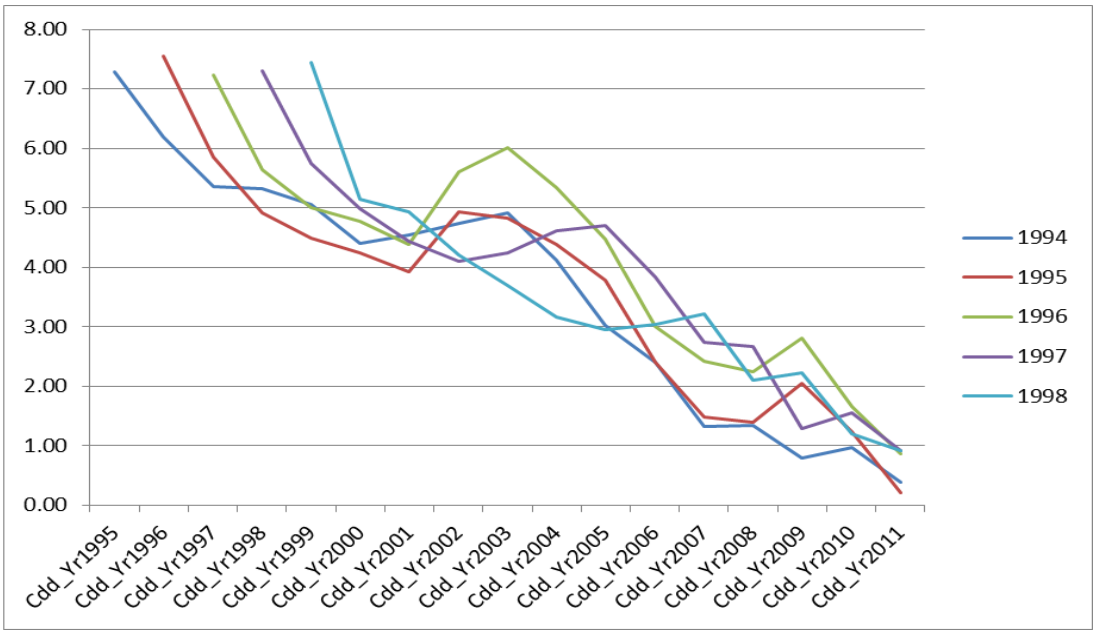


Figure 3. Cash Draw Down as Percentage of Initial Principle Limit by Calendar Year (Excludes First Year) for Selected Cohorts with Annual Adjustable Loans



Both figures indicate that the average cash draw tend to decrease as loan age (policy year) increases. However, there are jumps of cash draw from time to time for each cohort. By showing

the cash draw down in the calendar year, Figure 2 exhibits a clear trend of cash draw increase from year 2001 to 2004. Compared with the macroeconomic conditions presented in Figure 4 and Figure 5, these years have relatively low interest rates and high house price appreciation. As a result, it suggests that the borrowing behavior of senior households is a dynamic process that might depend on the current and expected future economic conditions.

Figure 4. Historical Interest Rates

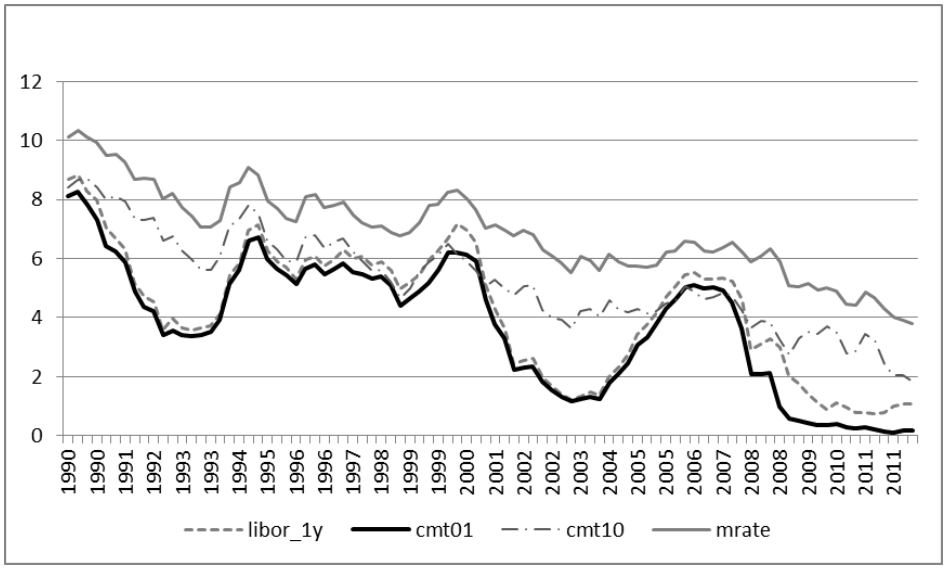
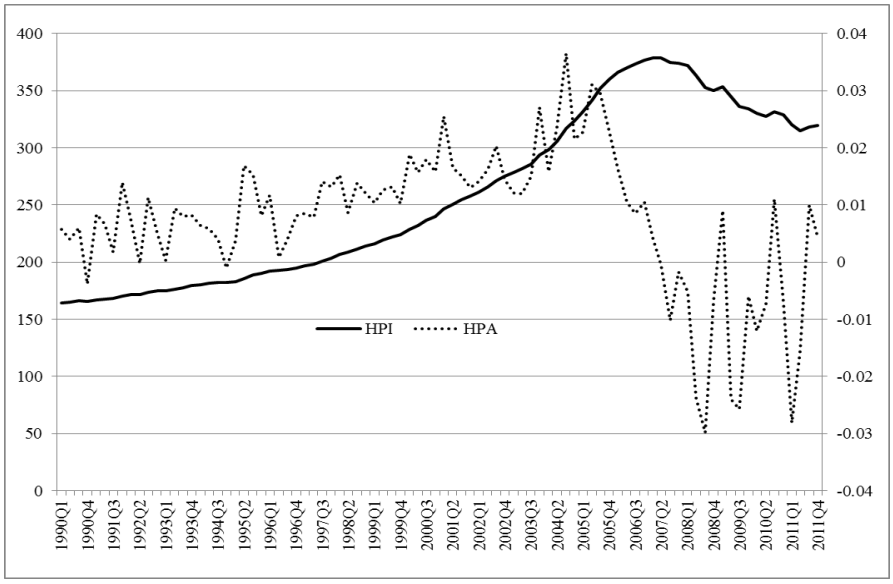


Figure 5. Historical House Price Index and House Price Appreciation Rate



Empirical Analysis

The panel data of cash draw is used to study the borrowing behavior of HECM borrowers. As the theoretical model suggest, how much a HECM borrower wants to borrow against the property depends on the level of consumption, income and wealth. Wealth level varies with house price appreciation rate and interest rate since borrowers have the option to refinance into a HECM loan with a higher principle limit. The optimal consumption path is a function of borrowers' preference as well as economic status, so that:

$$\text{Cash Draw}_t = f(X_t, Z)\, W_t \quad (9)$$

X includes time varying variables such as income and wealth. Z includes all time invariant variables that are related to borrowers' preference such as gender, race, education and initial wealth.

Because HECM program does not require information regarding borrowers' social-economic status except for the gender, marital status and age, it is impossible to estimate equation (9) with a full set of independent variables. However, assuming effect from each variable in f( ) is linearly separable, we have:

$$\text{Cash Draw}_t/W_t = X_t\beta + Z\gamma \quad (10)$$

Thus:

$$\Delta\text{Cash Draw\%}_t = \Delta X_t\beta \quad (11)$$

Therefore a fixed effect regression can be used to study the effect of time varying variables, and the effect of time-invariant variables will be absorbed by the fixed effect of each borrower. Another benefit of using fixed effect regression is to avoid data censoring problem, which is caused by loan termination due to refinance. Since the data does not allow us to link the refinanced loan to the original HECM loan, we are unable to observe the cash draw pattern after loan terminates. The fixed effect model allows us to analyze borrower behavior change in response to expected future economic condition before the loan terminates, therefore avoid the censored data problem.

Baseline Estimation

The baseline regression function is as follows:

$$\text{Cash Draw\%}_{i,t} = \text{HPI}_{s,t} * \beta_1 + int_t * \beta_2 + \text{loan\_age}_{i,t} * \beta_3 + i + \varepsilon_{i,t} \quad (12)$$

Where HPI is the regional house price index from Moody's for borrower *i*'s property location *s*, and *int* is the ten year Treasury rate. Estimation results are shown in Table 3. Model 1 is the simplest specification based on equation (12) using the full sample observations. Both variables have significant impact on percentage of cash draw. The signs are also consistent with the theoretical model in the previous section. Borrowers increase cash draw when house price increase or interest rate decrease. The result also indicates that interest rate has a much larger magnitude of impact on borrowing behavior: if interest rate drops by one percentage point, borrowers would borrow 0.45 percent more out of the principle limit. Consequently, the decrease of ten year Treasury rate from 6% to 2% can cause borrowing to increase by almost 2%, which would account for the jump of cash draw observed in Figure 3. The limited impact of HPI could be because HECM borrowers do not expect their property value to rise at the same rate of regional average due to depreciation and other reason. Coefficients of policy year (loan age) suggest that borrowers' cash draw on average decreases over time[9].

Model 2 includes both the lead and lag of economic variables to analyze how forward or backward looking HECM borrowers are. We find that the current HPI and past HPI have larger magnitude of impact than future HPI. The current and the future interest rate have larger influence on borrowing behavior. This could imply that borrowers form their expectation of house price based on historical house price, but can be more forward looking when it comes to the interest rate. The result also suggests that when borrowers expect future house price to increase, they would borrow less in the current period. When the future interest rate is expected to decrease, borrowers would also borrow more in the current period. The combined impact of interest rate is larger in Model 2 than Model 1.

Even though our theoretical model with bequest motive does not provide an explicit conclusion on borrowing behavior, it is possible that when the economic condition deteriorates, senior households may want to borrow more to help out their children, or they might get an early retirement which causes disruption of their income. Therefore, we add in regional unemployment rate (UE) to control for these shocks in model 3. The positive coefficient of UE suggests that senior households increase borrowing when unemployment rate increases. The signs for all HPI and interest rate variables stay the same, and value of these coefficients changed only by little.

[9] All the estimation controls for policy year. Coefficients for policy years are dropped for exhibition purpose.

For senior households, medical bill has a large impact on the household spending. We also see from our theoretical model that the expectation of death in the future changes the consumption pattern of a borrower. For this reason, age and gender specific mortality rate is added into Model 3 as well. We find that the mortality rate has a negative impact on borrowing, which might be caused by the correlation of mortality with age. Since senior households' consumption decreases with age, and a higher age corresponds to a higher mortality rate, borrowing would also decrease with mortality.

Model 4 includes interaction terms with marital status. Results show that married couples respond to changes of interest rate and HPI more than single borrowers. The unemployment rate also has a larger impact on married couples. All other non-interaction variables have very similar impact compared with Model 3.

To summarize, the baseline estimation finds consistent results compared with the theoretical model. HECM borrowers adjust borrowing behavior according to economic conditions. Specifically, senior households would increase their borrowing when house price increases, or interest rate decreases. We also find that households' behavior differ between married and single borrowers.

Subgroup Analysis

As we see from the data and the explanation in previous sections, fixed rate HECM loans are more affected by institutional factors. Since the percentage of fixed rate HECM is relatively low before 2007, from now on, I would focus on adjustable rate HECM sample. As observed in the data and other research, the characteristics of HECM borrowers differ among various origination years. Based on the trend observed in the last section, I divide the sample of ARM HECM into three subgroups: pre-2000 cohorts, 2000-2006 cohorts and 2007-2008 cohorts. The same set of variables as Model 4 is included in the subsample analysis.

Estimation result in Table 4 indicates that HECM borrowers behave differently among three subgroups. House price has a larger effect on HECM loans originated before 2006 compared with post-2006, while interest rate has a larger effect on 2007-2008 cohorts. Across cohorts, we still find a larger magnitude of impact from interest rate compared with HPI.

Table 3. Baseline Estimation Result using Full Sample

	1		2		3		4	
Parameter	**Estimate**	**Standard Error**	**Estimate**	**Standard Error**	**Estimate**	**Standard Error**	**Estimate**	**Standard Error**
HPI	0.00559	0.00012	0.00672	0.00032	0.00711	0.00032	0.00682	0.00034
Lead HPI			-0.00181	0.00023	-0.00142	0.00023	-0.00143	0.00023
Lag HPI			-0.00307	0.00021	-0.00235	0.00022	-0.00237	0.00022
CMT 10	-0.45265	0.00965	-0.18734	0.01039	-0.15128	0.01084	-0.11710	0.01317
Lag CMT10			0.04964	0.01082	0.11760	0.01247	0.11677	0.01247
Lead CMT10			-0.45006	0.00663	-0.41379	0.00742	-0.41363	0.00742
Unemployment Rate (UE)					0.05418	0.00455	0.04115	0.00527
Mortality Rate					-34.24726	0.65275	-33.08229	0.66132
HPI*Married							0.00087	0.00027
CMT 10 *Married							-0.09146	0.01977
UE*Married							0.03211	0.00677
R-Square	0.394789		0.396601		0.397655		0.397698	
Number of Observations	2145813							

Table 4. Subgroup Estimation Result using ARM Sample

ARM	All Years			Pre 2000			2000-2006			2007-2008		
Parameter	**Estimate**	**Standard Error**	**Pr > |t|**	**Estimate**	**Standard Error**	**Pr > |t|**	**Estimate**	**Standard Error**	**Pr > |t|**	**Estimate**	**Standard Error**	**Pr > |t|**
HPI	0.007	0.0003	<.0001	0.005	0.002	0.0229	0.006	0.0004	<.0001	0.002	0.0007	0.0015
Lead HPI	-0.001	0.0002	<.0001	-0.003	0.001	0.006	0.000	0.0003	0.7496	0.000	0.0005	0.4706
Lag HPI	-0.002	0.0002	<.0001	-0.002	0.001	0.238	-0.002	0.0003	<.0001	-0.002	0.0005	0.0003
CMT 10	-0.123	0.0132	<.0001	-0.125	0.034	0.0002	-0.064	0.0190	0.0007	-0.176	0.0295	<.0001
Lag CMT10	0.113	0.0125	<.0001	-0.122	0.030	<.0001	0.204	0.0182	<.0001	0.316	0.0281	<.0001
Lead CMT10	-0.419	0.0075	<.0001	-0.064	0.026	0.0135	-0.446	0.0112	<.0001	-0.438	0.0221	<.0001
Unemployment Rate (UE)	0.042	0.0053	<.0001	0.158	0.017	<.0001	0.057	0.0076	<.0001	0.023	0.0119	0.0514
Mortality Rate	-33.101	0.6628	<.0001	-30.699	1.096	<.0001	-29.345	0.9769	<.0001	-66.261	2.2153	<.0001
HPI*Married	0.001	0.0003	0.0013	0.001	0.001	0.0891	0.001	0.0004	0.1077	0.004	0.0007	<.0001
CMT 10 *Married	-0.093	0.0199	<.0001	-0.133	0.047	0.0051	-0.118	0.0284	<.0001	-0.062	0.0457	0.1726
UE*Married	0.032	0.0068	<.0001	-0.076	0.024	0.0018	0.031	0.0090	0.0006	0.055	0.0123	<.0001
Obs	2135655									254261		
R-Square	0.397									0.324		

For the 2000-2006 cohorts, HECM households increase their borrowing in response to the future house price increase, while the other two subgroups is the opposite. A lower interest rate from the last period increases current borrowing for pre-2000 cohorts while it is the opposite for the other two subgroups.

Unemployment rate has a bigger impact on pre-2000 cohorts than the other two groups. Married households have larger respond to changes of economic conditions in three subgroups.

It is possible that the different responses observed among three subgroups are caused by their initial status and initial borrowing amount (Table A1-A2). Because we cannot separate closing cost from the initial borrowing and borrowers may or may not use out-of-pocket money to pay the closing cost, I exclude the first year cash draw from the analysis. Therefore it is difficult to isolate its impact.

Dynamics of Borrow Behavior Analysis

In order to study whether borrowers adjust their behavior as economic condition changes, I select three periods which experienced dramatic changes of interest rate or HPI and estimate whether borrowers response different during these periods. The estimation results based on the full sample of ARM HECM is shown in Table 5.

The "HP Jump" is year 2003-2004 where house price started to increase at an increasing speed. "CMT Jump1" refers to year 2008-2009 where interest rate dropped to a historically low level from a relatively high level. "CMT Jump2" refers to year 2000-2003 which is also a period of fast interest rate decrease.

Model 5 includes HP Jump and CMT Jump1 using the full sample of ARM HECM loans. We find that households did change their borrowing behavior during the period of dramatic condition changes. Borrowers increased their response to interest rate during the period of big interest rate decrease. On the other hand, the respond to HPI does not show a significant change during HP Jump, but rather, the effect is more likely to be correlated with the simultaneous drop of interest rate during this period. Therefore, I drop HP Jump and add in CMT Jump2 into Model 6, and find similar result as Model 5: borrowers increase cash draw by more in response to interest rate changes during the period of fast interest rate drop, while the changes to HPI are non-significant.

Next, I divide the sample into the same three subgroups as before and interesting results are observed in Table 6.

Table 5. Estimation Results for ARM HECM with Jumps

ARM	5			6		
Parameter	**Estimate**	**Standard Error**	**Pr > |t|**	**Estimate**	**Standard Error**	**Pr > |t|**
HPI	0.005325	0.000406	<.0001	0.004967	0.000406	<.0001
Lead HPI	-0.00058	0.000275	0.0348	-0.00053	0.000275	0.0548
Lag HPI	-0.00139	0.000271	<.0001	-0.00153	0.00027	<.0001
CMT 10	-0.15798	0.013981	<.0001	-0.14993	0.013915	<.0001
Lag CMT10	0.128705	0.013149	<.0001	0.146751	0.013136	<.0001
Lead CMT10	-0.44829	0.008297	<.0001	-0.46362	0.008356	<.0001
Unemployment Rate (UE)	0.043252	0.005357	<.0001	0.040273	0.005368	<.0001
Mortality Rate	-33.1094	0.66284	<.0001	-33.0652	0.66282	<.0001
HPI*Married	0.000868	0.000269	0.0012	0.00088	0.000269	0.0011
CMT 10 *Married	-0.09194	0.019858	<.0001	-0.09211	0.019857	<.0001
UE*Married	0.031628	0.006792	<.0001	0.031987	0.006791	<.0001
HPI* HP Jump	-1E-05	0.000241	0.9656			
CMT10* HP Jump	-0.04157	0.013823	0.0026			
HPI*CMT Jump1	-3.4E-05	7.95E-05	0.6658	1.15E-05	7.95E-05	0.8849
CMT10*CMT Jump1	-0.02758	0.006984	<.0001	-0.03522	0.007004	<.0001
HPI*CMT Jump2				-0.00026	0.000204	0.2064
CMT10*CMT Jump2				-0.06152	0.009761	<.0001
R-Square	0.397406			0.397467		

The pre-2000 cohort results suggest that, during the period of fast house price appreciation, households reduced their borrowing response to HPI, since the coefficient of the interaction term between HPI and HP Jump is negative and significant. The interaction between CMT and the CMT Jump has a positive coefficient, which also suggests that these households are reducing their borrowing response to interest rate when interest rate experienced a big drop. Combining the two factors, we find that pre-2000 cohorts might be more conservative since they tend to restrain borrowing when changes of economic condition seem to be unsustainable. Similar results are observed when two CMT jumps are included in the model for pre-2000 cohorts.

Table 6. Subgroup Result of Borrowing Dynamics												
ARM	**Pre 2000**			**Pre-2000**			**2000-2006**			**2007-2008**		
Parameter	**Estimate**	**Standard Error**	**Pr > |t|**	**Estimate**	**Standard Error**	**Pr > |t|**	**Estimate**	**Standard Error**	**Pr > |t|**	**Estimate**	**Standard Error**	**Pr > |t|**
HPI	0.0062	0.0023	0.0058	0.0058	0.0023	0.0096	0.0045	0.0005	<.0001	0.0004	0.0008	0.6291
Lead HPI	-0.0033	0.0012	0.007	-0.0032	0.0012	0.0071	0.0006	0.0004	0.1225	0.0005	0.0007	0.5133
Lag HPI	-0.0033	0.0015	0.03	-0.0029	0.0015	0.0512	-0.0008	0.0004	0.0286	-0.0011	0.0005	0.0404
CMT 10	-0.0703	0.0366	0.0552	-0.1403	0.0356	<.0001	-0.1092	0.0203	<.0001	-0.1009	0.0317	0.0015
Lag CMT10	-0.0924	0.0310	0.0029	-0.1297	0.0304	<.0001	0.2263	0.0188	<.0001	0.4030	0.0294	<.0001
Lead CMT10	0.0109	0.0305	0.721	-0.0603	0.0299	0.0434	-0.4654	0.0121	<.0001	-0.3651	0.0231	<.0001
Unemployment Rate (UE)	0.1540	0.0172	<.0001	0.1609	0.0172	<.0001	0.0669	0.0077	<.0001	0.0727	0.0127	<.0001
Mortality Rate	-30.6691	1.0961	<.0001	-30.6808	1.0962	<.0001	-29.4570	0.9771	<.0001	-65.9901	2.2153	<.0001
HPI*Married	0.0011	0.0006	0.0897	0.0011	0.0006	0.0887	0.0006	0.0004	0.1011	0.0038	0.0007	<.0001
CMT 10 *Married	-0.1316	0.0474	0.0055	-0.1322	0.0474	0.0053	-0.1160	0.0284	<.0001	-0.0611	0.0457	0.1815
UE*Married	-0.0756	0.0244	0.002	-0.0762	0.0244	0.0018	0.0308	0.0090	0.0006	0.0537	0.0123	<.0001
HPI* HP Jump	-0.0008	0.0004	0.0269				0.0010	0.0004	0.007			
CMT10* HP Jump	0.0895	0.0223	<.0001				-0.1401	0.0211	<.0001			
HPI*CMT Jump1	0.0006	0.0005	0.229	0.0005	0.0005	0.3356	-0.0001	0.0001	0.1927	0.0003	0.0002	0.0887
CMT10*CMT Jump1	0.0222	0.0418	0.5963	0.0041	0.0420	0.9215	-0.0197	0.0090	0.0279	-0.1658	0.0173	<.0001
HPI*CMT Jump2				-0.0008	0.0003	0.015						
CMT10*CMT Jump2				0.0288	0.0140	0.0398						
R-Square	0.324092			0.324046			0.384977			0.449783		

On the other hand, the opposite is observed for post 2000 cohorts. For cohorts between 2000-2006, the result shows that HPI effect increases during the period of fast house price appreciation, and interest rate effect increases during the period of fast interest rate drop. This implies that households increased their borrowing at a faster speed during these two jump periods. For post-2006 cohorts, they only experienced a CMT Jump period. The coefficient suggests a similar result: interest rate impact increases during the period of big rate drop. Based on these result, it is likely that post-2000 cohorts tend to over-react to changes in economic conditions, which could have a negative effect on their long-term welfare. The impact depends on households' preference.

The bottom line from the above analysis is that the dynamics of borrowing behavior varies among different cohorts of borrowers. The pre-2000 HECM borrowers appear to be more conservative than the post-2000.

Conclusion

Economic conditions are found to be important elements that affect borrowing behavior in the reverse mortgage. The life-cycle model suggests that households would adjust consumption upward when house price is expected to increase or interest rate is expected to decrease. As HECM households tend to be "cash poor, house rich", the increasing consumption requires an increase in the borrowing from their own housing equity.

Empirical estimation based on the annual cash draw data of HECM borrowers finds consistent result compared with the theoretical model. And the borrowing behavior differs among households with different characteristics, such as marital status. Analysis based on subgroups of HECM borrowers by loan origination year indicates that the more recent HECM cohorts exhibit different borrowing behavior compared with earlier cohorts. However, the general pattern is consistent across three subgroups: households borrow more when house price increases or interest rate decreases and the impact of interest rate has a larger magnitude.

The analysis of borrowing dynamics based on the change of response to economic variables during selected periods further indicates the differences of borrowers between the earlier cohorts and the more recent ones. The earlier cohorts (pre-2000) are found to be more conservative that their response to economic variables decreases during the period of volatile HPI or interest rate. It is likely that the recent cohorts tend to over-react to condition changes which could distort the future consumption and have negative impact on their welfare. More information about the households will be helpful in understanding borrowers' behavior change and analysis the impact on senior households' welfare.

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Appendix

Table A1. First-Month Borrower Cash Draw of FY 2009-FY 2011 HECM Endorsements as a Percentage of the Initial Principal Limit

Endorsement Fiscal Year	Age Group	Number of Loans	Variable Rate Loans			Fixed Rate Loans	
			0-40%	40-80%	80-100%	0-80%	80-100%
2009	62-65	23,713	11.9%	23.7%	50.9%	0.3%	13.3%
	66-70	28,217	14.5%	24.3%	48.1%	0.2%	12.9%
	71-75	24,935	18.9%	24.4%	45.3%	0.1%	11.3%
	76-85	28,906	24.7%	24.0%	41.3%	0.1%	9.8%
	85+	8,669	35.2%	20.1%	36.8%	0.1%	7.7%
	Total	114,440	19.1%	23.8%	45.5%	0.2%	11.4%
2010	62-65	17649	7.4%	8.1%	4.4%	1.3%	79.5%
	66-70	18,824	9.3%	9.8%	5.2%	1.1%	75.2%
	71-75	16,653	13.5%	11.5%	5.9%	0.8%	68.9%
	76-85	19,456	19.9%	14.1%	6.8%	0.8%	58.9%
	85+	6,496	31.7%	14.7%	8.6%	0.5%	44.8%
	Total	79,078	14.2%	11.2%	5.8%	0.9%	67.8%
2011	62-65	18,804	8.6%	10.2%	5.1%	1.1%	77.7%
	66-70	18,017	11.0%	10.8%	5.0%	1.1%	74.8%
	71-75	14,802	15.7%	11.9%	5.0%	0.9%	68.8%
	76-85	16,051	22.6%	13.9%	5.3%	0.9%	59.1%
	85+	5,456	36.2%	13.2%	5.6%	0.5%	45.5%
	Total	73,130	15.8%	11.7%	5.1%	0.9%	66.3%

Source: IFE Group (2012). *Actuarial Review of the Federal Housing Administration Mutual Mortgage Insurance Fund HECM Loans For Fiscal Year 2012*. U. S. Department of Housing and Urban Development: Washington, D.C.

Table A2. Percent Cash Draw of Annual Adjustable Rate HECM by Policy Year

Year		Cdd_Prct1	Cdd_Prct2	Cdd_Prct3	Cdd_Prct4	Cdd_Prct5	Cdd_Prct6	Cdd_Prct7	Cdd_Prct8	Cdd_Prct9	Cdd_Prct10	Cdd_Prct11	Cdd_Prct12	Cdd_Prct13	Cdd_Prct14	Cdd_Prct15	Cdd_Prct16	Cdd_Prct17	Cdd_Prct18	Cdd_Prct19
1989	A	37.56	7.36	6.69	7.71	8.42	5.61	17.28	2.12	2.83	1.10	0.05	1.79							
1990	A	45.84	9.60	8.61	7.26	6.86	6.18	8.03	6.96	5.26	5.01	4.69	3.35	2.01	1.21	2.98	4.13	1.52	0.63	5.56
1991	A	48.79	9.05	8.19	7.13	7.21	6.54	5.60	6.03	5.80	4.13	3.68	6.35	2.20	1.99	1.37	1.49	0.19	0.33	0.00
1992	A	50.87	7.55	6.53	6.61	6.00	4.93	5.06	4.58	3.92	3.90	3.22	2.96	2.29	1.83	1.61	1.45	1.71	1.22	2.54
1993	A	51.67	7.48	6.22	5.24	4.73	4.09	4.02	3.54	3.26	3.02	2.35	1.92	1.62	1.03	0.67	0.46	0.30	0.55	0.37
1994	A	53.26	7.28	6.20	5.36	5.32	5.05	4.41	4.55	4.73	4.91	4.12	3.02	2.40	1.32	1.34	0.79	0.97	0.39	
1995	A	53.22	7.55	5.85	4.92	4.50	4.24	3.93	4.94	4.83	4.39	3.78	2.41	1.48	1.40	2.05	1.23	0.20		
1996	A	52.41	7.24	5.64	5.01	4.78	4.39	5.61	6.00	5.34	4.47	3.00	2.43	2.25	2.80	1.65	0.87			
1997	A	51.47	7.31	5.75	4.98	4.44	4.11	4.24	4.62	4.70	3.83	2.74	2.67	1.29	1.56	0.93				
1998	A	50.07	7.44	5.14	4.93	4.20	3.69	3.16	2.95	3.04	3.21	2.11	2.22	1.20	0.91					
1999	A	49.24	6.02	4.50	5.58	4.05	3.42	3.63	3.74	2.86	3.05	2.15	1.35	1.33						
2000	A	52.29	7.40	5.50	5.68	4.45	3.45	2.55	3.70	2.62	4.53	3.80	1.39							
2001	A	41.71	7.41	5.82	4.61	4.61	4.69	3.82	3.85	2.80	3.53	1.27								
2002	A	43.05	6.79	6.03	4.79	4.42	3.55	3.33	3.96	2.76	0.52									
2003	A	38.87	7.06	5.68	4.90	4.46	4.47	3.74	3.29	1.18										
2004	A	41.99	7.83	6.20	5.32	4.79	3.89	4.05	1.90											
2005	A	43.14	7.67	5.89	5.06	4.50	4.50	2.92												
2006	A	48.02	8.25	6.28	4.89	4.62	2.57													
2007	A	54.56	6.36	4.83	4.20	0.83														
2008	A	55.73	5.52	4.71	2.00															
2009	A	53.94	6.38	3.84																