THE OHIO STATE UNIVERSITY

An Analysis of Default Risk in the Home Equity Conversion Mortgage (HECM) Program

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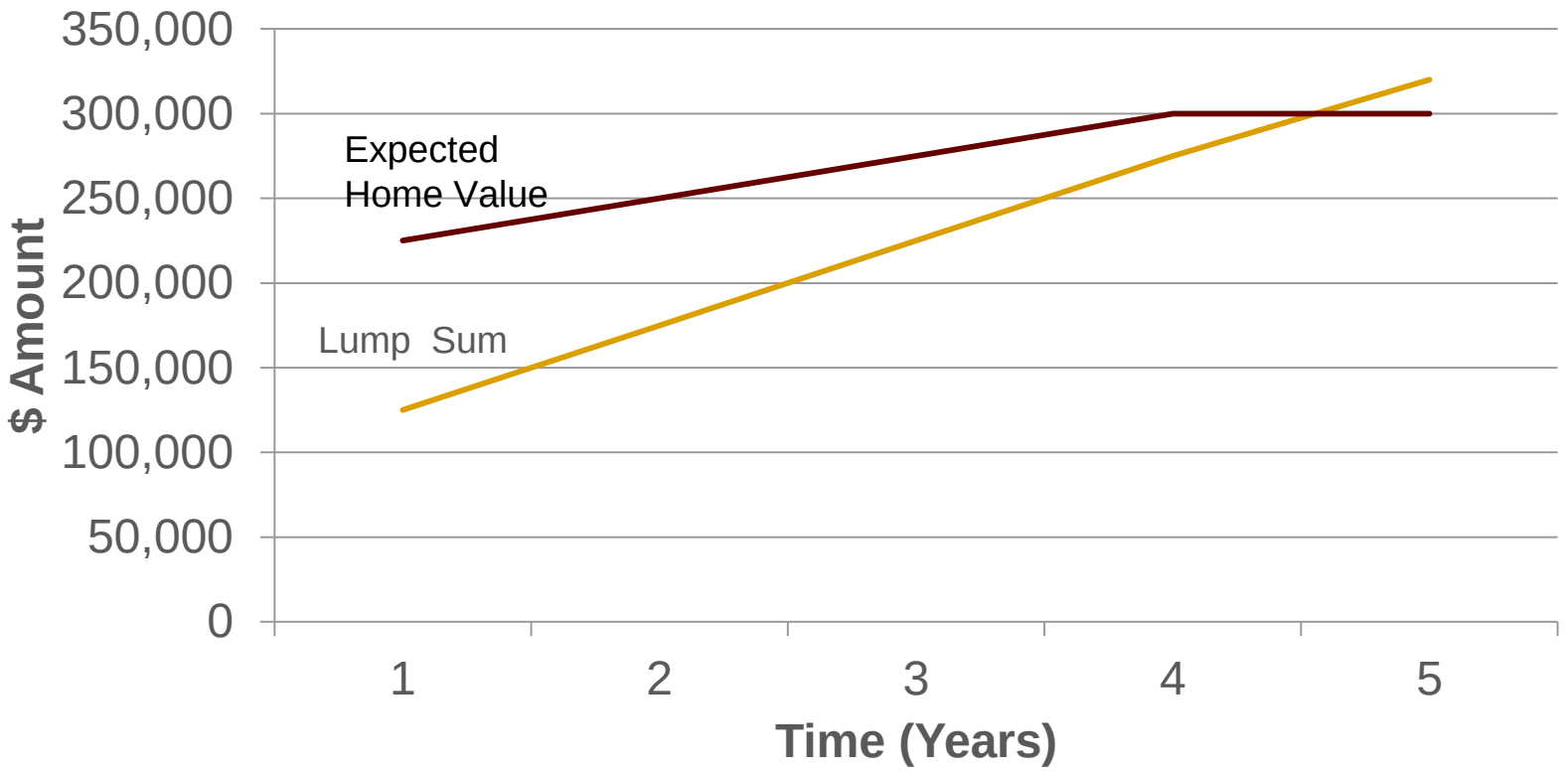
Reverse Mortgage 101

- In the U.S, the federally insured Home Equity Conversion Mortgage (HECM) comprises 95% of the market. Small, but potentially growing market.

- Extract equity from the home through a mortgage that does not become due until the last borrower sells the home, moves out permanently, or dies, as long as the borrower meets the obligations of the mortgage note
  - Obligations include living in the home as primary residence, **pays property taxes, homeowners insurance**, homeowners association dues and assessments, and maintains the home.

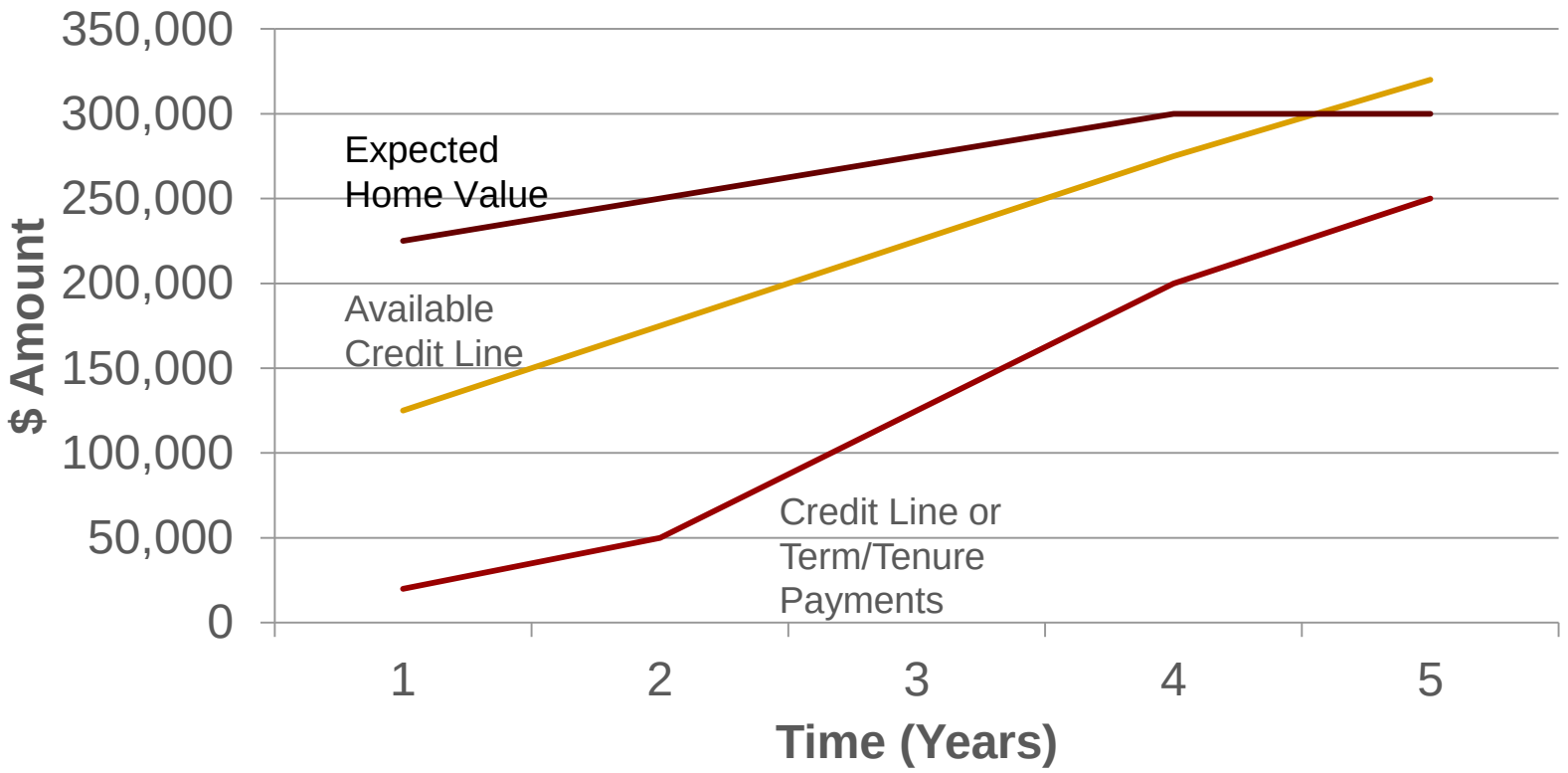
- No payments on the loan are required during the life of the loan. Money borrowed, plus associated interest and fees, are added to the balance due that continues to grow over time (mortgage “in reverse”)
  - Line of Credit
  - Tenure or Term (similar to annuity)
  - Lump Sum Distribution
  - Some combination of the above

Reverse Mortgage Debt



Maximum Claim Amount (home value at closing)= $225,000
Initial Principal Limit = $125,000

Reverse Mortgage Debt



Maximum Claim Amount (home value at closing)= $225,000
Initial Principal Limit = $125,000

Motivation & Contributions

- As of 2012, **9.4 percent** of all HECM borrowers were in technical default:
  - failed to pay property taxes and/or homeowner's insurance; AND
  - exhausted all available proceeds on the reverse mortgage.

- Risk- based **underwriting criteria** to be implemented for the first time. No prior underwriting based on borrower risk or ability to pay; lack of data.

- We isolate factors at origination that **predict technical default** , taking into account selection into the reverse mortgage and withdrawals of HECM funds. We simulate the effect of policies on both take-up and default:
  - withdrawal limits
  - risk-based underwriting thresholds and set-asides

- We simultaneously model three decisions:
  - whether or not to take out a reverse mortgage
  - amount of money to withdraw up-front
  - default on property taxes or homeowner's insurance

Previous research & theoretical expectations

- Prior literature
  - **Reverse mortgage borrower selection & take-up**
    (Shan 2011; Nakajima and Telyukova 2013; Davidoff 2014; Haurin et al. 2014)
  - **Reverse mortgage terminations**
    (Rodda, Lam and Youn 2004; Szymanoski, Enriquez, and DiVenti 2007; Bishop and Shan 2008; Shan 2011; Davidoff 2013; IFE 2011; 2012 ; 2013)

- Expectations for technical default
  - **Theoretical perspectives**
    - Options theory; lack of applicability of negative equity for HECMs
    - Triggering events; factors at origination that increase vulnerability (e.g. illiquidity)
    - Financial management; lumpy infusion of cash and large infrequent payments (Agarwal et al. 2007; Anderson and Dokko 2011; Elul et al. 2010)
  - **Explanatory factors**
    - **Household financial position**
      - Cash flow deficiencies, liquidity constraints and poor credit management
    - **Management of HECM funds**
      - Proportion of available funds withdrawn up-front

Model: Truncated Bivariate Probit, with Endogenous Regressor

A household's selection into HECM is modeled as

$$HECM_i = \begin{cases} 1 \; if \; X_i\beta_1 + S_i\gamma + u_{1i} > 0 \\ 0 \; otherwise \end{cases}$$

D_i=1 indicates that borrower i defaults. D_i is observed only if the person is a HECM borrower: $HECM_i$=1.

$$D_i = \begin{cases} 1 \; if \; X_i\beta_2 + Z_i\delta + W_i\alpha + u_{2i} > 0 \; and \; HECM_i = 1 \\ 0 \; if \; X_i\beta_2 + Z_i\delta + W_i\alpha + u_{2i} \leq 0 \; and \; HECM_i = 1 \end{cases}$$

A household's initial withdrawal W_i is modeled as

$$W_i = X_i\beta_3 + H_i\theta + u_{3i}$$

W_i is observed only if the household obtained HECM. We estimate the three equations simultaneously (selection, withdrawal and T&I default)

Model: Truncated Bivariate Probit, with Endogenous Regressor

X_i in all equations, includes demographic characteristics, income, property tax burden, debt burdens, FICO, credit characteristics, delinquencies, state and year fixed effects

S_i only in selection equation	Z_i only in default equation	H_i only in withdrawal equation
Estimated Net Initial Principal Limit	Net Initial Principal Limit	Actual Initial Principal Limit
Excess of home value above MCA	% upfront draw (W_i)	Mortgage/IPL
State house price deviation from the state's long run norm	Difference between the date of origination and July 2012 or the date of termination	Fixed rate policy dummy (=1 after Apr 1, 2009)
		Interaction between fixed rate dummy & spread between average interest rates of FRM and ARM.

Data

1. Counseling data
   - 2006 - 2011, including more than 30,000 seniors
2. Credit report data
   - time of counseling & annually thereafter
3. Economic indicators
   - national, state and county level, time varying
4. HUD HECM loan data
   - includes T&I defaults

COUNSELED (N=28,129)	HECM (N=16,283)	T&I Default (N=1,173)
	57.9%	7.2%

Results and Policy Simulation

- **Results**
  - Focus variables associated with default.
  - The equations of selection, default and initial withdrawal are jointly estimated.

- **Policy simulation**
  - Management of HECM funds
    - Initial withdrawal limit
  - Eligibility
    - Credit score threshold
    - Credit risk threshold
    - Escrow account: LESA (life expectancy set-aside)

Results

Truncated Bivariate Probit

	Default
Property taxes/income	0.0337***
FICO credit score	-0.0002***
Available revolving credit	-0.0003***
No revolving credit	0.0157***
Mortgage past due	0.0155***
Tax lien or judgment	0.0111***
Hispanic	0.0149***
Race, white	-0.0069*
Race, black	0.0114***
Unmarried male	0.0158***
Unmarried female	0.0047*
Age, youngest member	-0.0014
Initial withdrawal %	0.0620***

*** p<0.01, ** p<0.05, *p<0.1

Probit estimates reported as conditional marginal effects (default). Robust standard errors in parentheses. State and year fixed effects included.

- A 100 point increase in credit score is associated with a 2.3 percentage point decrease in default rate.
- Illiquidity; no revolving credit associated with 1.57 percentage point increase
- Prior tax liens associated with 1.1 percentage point increase in default rate
- Minority borrowers' default rates are about 2 percentage points higher than non-minority borrowers.
- A 10 percentage point increase in the initial withdrawal is associated with a .62% increase in the default rate.
- Correlation of unobservables
  - HECM, Default: 0.0313
  - HECM, Withdrawal: 0.4486 ***
  - Default, Withdrawal: 0.0492

Policy Simulations

- Impose new up-front draw limits
  - No mortgage debt: 60% IPL
  - If mortgage debt: payoff, up-front costs + 10% IPL
  - Simulation assumptions:
    - HECM take-up based on lesser of observed draw or max draw limit

- Impose credit risk thresholds & set-asides
  - Apply thresholds based on credit score and credit report attributes
  - If hhld fails threshold, see if hhld could afford set-aside from net IPL
    - Fail, afford set-aside: get HECM, T&I default = 0
    - Fail, not afford set-aside: do not get HECM (T&I default not observed)
  - Set-aside simulation assumptions:
    - Set-aside estimates based on 2008-2010 property tax rates
    - Threshold is hard cut-off requiring set-aside
    - Those who are required to take set aside have IPL reduced by set-aside amount $
    - T&I default rate for those taking set-aside is 0%

Policy Simulations: Initial Withdrawal Limits

Table 5, Policy Simulations

Policy Simulations	%Δ in Predicted HECM volume	Δ in T&I Default Rate	% Δ in T&I Default Rate[3]
Initial Withdrawal Limit			
Initial withdrawal limit	-19.92%	-1.49	-21.32%
Credit Score Thresholds			
Credit Risk Thresholds			

Policy Simulations: Credit Score Thresholds

Table 5, Policy Simulations

Policy Simulations	%Δ in Predicted HECM volume	Δ in T&I Default Rate	% Δ in T&I Default Rate[3]
Initial Withdrawal Limit			
Initial withdrawal limit	-19.92%	-1.49	-21.32%
Credit Score Thresholds			
Hard limit: credit score >= 500	-3.18%	-0.87	-12.37%
Hard limit: credit score >= 580	-13.80%	-2.57	-36.69%
Set-aside for credit score less than 500	-0.93%	-1.04	-14.82%
Set-aside for credit score less than 580	-4.01%	-3.11	-44.49%
Set-aside for credit score less than 500 + initial draw limit	-20.76%	-2.37	-33.83%
Set-aside for credit score less than 580 + initial draw limit	-23.65%	-4.05	-57.88%
Credit Risk Thresholds			

Policy Simulations: Credit Risk Indicators

Table 5, Policy Simulations

Policy Simulations	%Δ in Predicted HECM volume	Δ in T&I Default Rate	% Δ in T&I Default Rate[3]
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Initial withdrawal limit	-19.92%	-1.49	-21.32%
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Hard limit: credit score >= 500	-3.18%	-0.87	-12.37%
Hard limit: credit score >= 580	-13.80%	-2.57	-36.69%
Set-aside for credit score less than 500	-0.93%	-1.04	-14.82%
Set-aside for credit score less than 580	-4.01%	-3.11	-44.49%
Set-aside for credit score less than 500 + initial draw limit	-20.76%	-2.37	-33.83%
Set-aside for credit score less than 580 + initial draw limit	-23.65%	-4.05	-57.88%
Credit Risk Thresholds			
Hard limit: drop observations with bad credit	-18.84%	-2.31	-34.40%
Set-aside for bad credit	-5.42%	-3.05	-45.31%
Set-aside for bad credit + initial draw limit	-26.48%	-3.95	-58.68%

Implications & Conclusions

- Policy viability of HECM program
  - T&I defaults that result in foreclosure can contribute to fiscal insolvency of the MMI fund
  - “Headline risk” of program and perceived public value
- Mitigating default risk while not (overly) restricting access
  - Restrictions on initial withdrawals vs. credit underwriting thresholds
  - Added impact of set-asides for taxes and insurance
- Next steps:
  - Generalizing empirical model
  - Other outcomes of consumer well-being
  - Post-origination monitoring as innovation to reduce default

Questions?

Hypotheses

Variable	Withdrawal %	Default
Financial Resources & Expenditures		
Income	-	-
Borrowing capacity	-	-
Property tax burden	?	+
Debt ratios	+	+
Borrower Credit Risk		
Credit score	-	-
Tax liens	+	+
Missed mortgage payments	?	+
Management of HECM Funds		
Initial withdrawal %		+
Net IPL		-
Home debt/IPL	+	
Fixed rate, full draw policy	+	

Household Financial Characteristics (X_i)

	Counseled (N=28,129)		HECM (N=16,283)		Default (N=1,173)	
	mean	sd	mean	sd	mean	sd
Monthly income	2,311	1,717	2,337	1,660	1,849	1,204
Non-housing assets	42,260	179,408	41,945	174,284	22,465	138,547
Property taxes/income	0.091	0.095	0.096	0.098	0.112	0.105
FICO credit score	678	102	693	98	597	90
Revolving balance/income	0.231	0.453	0.252	0.475	0.161	0.411
Installment balance/income	0.236	0.496	0.221	0.479	0.291	0.583
Foreclosure started	0.021	0.143	0.011	0.105	0.033	0.180
Bankruptcy in last 12 months	0.011	0.105	0.007	0.083	0.013	0.114
Available revolving credit	22,556	37,411	25,754	38,308	8,411	19,746
No revolving credit	0.118	0.323	0.084	0.278	0.130	0.337
Mortgage past due, 2+ months	0.062	0.241	0.039	0.192	0.121	0.326
Tax lien or judgment	0.102	0.302	0.079	0.269	0.169	0.375

HECM Loan Characteristics

	Counseled (N=28,129)		HECM (N=16,283)		Default (N=1,173)	
	mean	sd	mean	sd	mean	sd
Initial withdrawal %			0.771	0.292	0.883	0.152
HECM Take-Up Equation (S_i)						
Estimated net IPL	84,555	82,014	93,186	81,251		
Excess home value amount	18,006	94,544	17,220	82,550		
Monthly mortgage payments	498	766	462	717		
HELOC indicator	0.130	0.337	0.140	0.347		
Initial Withdrawal Equation (H_i)						
Actual IPL			139,977	88,012	129,410	78,943
Home debt/IPL			0.387	0.350	0.470	0.346
Fixed rate policy indicator			0.736	0.441	0.477	0.500
Fixed rate policy*spread			-0.069	0.350	-0.110	0.317
Technical Default Equation (Z_i)						
Actual net IPL			83,147	75,391	63,851	59,713
Exposure days			799	483	1,118	466

Truncated Bivariate Probit with Endogenous Regressor

- HECM Selection

$$y_{i1}^* = x_{i1}'\beta_1 + z_i'\alpha_1 + \epsilon_{i1} \tag{1}$$

The household selects HECM ($y_{i1} = 1$) if $y_{i1}^* > 0$. Among HECM borrowers, initial withdrawal as a percentage of initial principal limit (w_i) and whether the borrower has defaulted on tax or insurance (y_{i2}) are observed.

- T&I default

$$y_{i2}^* = x_{i2}'\beta_2 + z_i'\alpha_2 + w_i\gamma_2 + \epsilon_{i2} \tag{2}$$

The household defaults ($y_{i2} = 1$) if $y_{i2}^* > 0$ and $y_{i1} = 1$.

- Withdrawal[1]

$$w_i = x_{i3}'\beta_3 + z_i'\alpha_3 + \epsilon_{i3} \tag{3}$$

Truncated Bivariate Probit with Endogenous Regressor

In Eqs. (1)-(3), z_i are common variables, x_{i1}, x_{i2}, x_{i3} are unique to each equation respectively. The unobservables $\begin{bmatrix}\epsilon_{i1} & \epsilon_{i2} & \epsilon_{i3}\end{bmatrix}$ are jointly normal with mean 0 and variance

$$\Sigma = \begin{bmatrix} 1 & \rho_{12} & \rho_{13}\sigma \\ \rho_{12} & 1 & \rho_{23}\sigma \\ \rho_{13}\sigma & \rho_{23}\sigma & \sigma^2 \end{bmatrix} \tag{4}$$

The unobservables are assumed to be independent from x_{i1}, x_{i2}, x_{i3} and z_i. The withdrawal w_i is correlating with ϵ_{i2} if ϵ_{i3} is correlated with ϵ_{i2}.

There are 3 cases.

	case 1	case 2	case 3	
y_{i1}	1	1	0	HECM take-up
y_{i2}	1	0	·	t&i default
w_i	observed	observed	·	initial withdrawal

Truncated Bivariate Probit with Endogenous Regressor

- Case 1: the household selects HECM $y_{i1} = 1$, withdraws w_i, and defaults $y_{i2} = 1$. The joint density is

$$
\begin{aligned}
l_{i1}(\theta) &= f(y_{i1} = 1, y_{i2} = 1, w_i = w | x_{i1}, x_{i2}, x_{i3}, z_i) \\
&= \int_{-x'_{i1}\beta_1 - z'_i\alpha_1} \int_{-x'_{i2}\beta_2 - z'_i\alpha_2 - w_i\gamma} \phi_3(\epsilon_1, \epsilon_2, w - x'_{i3}\beta_3 - z'_i\alpha_3) d\epsilon_1 d\epsilon_2 \qquad (5) \\
&= \int_{-x'_{i1}\beta_1 - z'_i\alpha_1} \int_{-x'_{i2}\beta_2 - z'_i\alpha_2 - w_i\gamma} \phi_{\epsilon_1,\epsilon_2|\epsilon_3 = w - x'_{i3}\beta_3 - z'_i\alpha_3}(\epsilon_1, \epsilon_2) f(w | x_{i3}, z_i) d\epsilon_1 d\epsilon_2 \qquad (6) \\
&= f(w | x_{i3}, z_i) \int_{-x'_{i1}\beta_1 - z'_i\alpha_1} \int_{-x'_{i2}\beta_2 - z'_i\alpha_2 - w_i\gamma} \phi_{\epsilon_1,\epsilon_2|\epsilon_3 = w - x'_{i3}\beta_3 - z'_i\alpha_3}(\epsilon_1, \epsilon_2) d\epsilon_1 d\epsilon_2 \\
&= f(w | x_{i3}, z_i) P(y_{i1} = 1, y_{i2} = 1 | x_{i1}, x_{i2}, x_{i3}, z_i, w_i = w) \qquad (7)
\end{aligned}
$$

Truncated Bivariate Probit with Endogenous Regressor

In Eq. (5), ϕ_3 is the density of trivariate normal distribution with mean $[0 \quad 0 \quad 0]$ and variance Σ as in Eq. (4). Then in Eq. (6), the trivariate normal density is written as a product of the marginal density of ϵ_{i3} and the conditional density of $\epsilon_{i1}, \epsilon_{i2}$ on $\epsilon_{i3} = w - x'_{i3}\beta_3 - z'_i\alpha_3$. The terms in Eq. (7) are

$$\log f(w_i = w|x_{i3}, z_i) \propto -\frac{1}{2}\log\sigma^2 - \frac{1}{2\sigma^2}(w - x'_{i3}\beta_3 - z'_i\alpha_3)^2,$$

$$\log P(y_{i1} = 1, y_{i2} = 1|x_{i1}, x_{i2}, x_{i3}, z_i, w_i = w) = \log \Phi_2(x'_{i1}\beta_1 + z'_i\alpha_1,\ x'_{i2}\beta_2 + z'_i\alpha_2 + w_i\gamma_2; \bar{\mu}_{i,1}, \bar{\Sigma}_1)$$

where $\Phi_2(\cdot, \cdot; \bar{\mu}_{i,1}, \Sigma_1)$ is the cdf of a bivariate normal $(\bar{\mu}_{i,1}, \Sigma_1)$. Using the property of multivariate normal distribution,

$$\bar{\mu}_{i,1} = \begin{pmatrix} -1 & 0 \\ 0 & -1 \end{pmatrix} \Sigma_{12}\Sigma_{22}^{-1}(w_i - x'_{i3}\beta_3 - z'_i\alpha_3) = \begin{pmatrix} -\frac{\rho_{13}}{\sigma} \\ -\frac{\rho_{23}}{\sigma} \end{pmatrix} (w_i - x'_{i3}\beta_3 - z'_i\alpha_3),$$

$$\bar{\Sigma}_1 = \Sigma_{11} - \Sigma_{12}\Sigma_{22}^{-1}\Sigma_{21} = \begin{pmatrix} 1 - \rho_{13}^2 & \rho_{12} - \rho_{13}\rho_{23} \\ \rho_{12} - \rho_{13}\rho_{23} & 1 - \rho_{23}^2 \end{pmatrix},$$

where $\Sigma_{11} = \begin{pmatrix} 1 & \rho_{12} \\ \rho_{12} & 1 \end{pmatrix}$, $\Sigma_{22} = \sigma^2$, $\Sigma_{12} = \begin{pmatrix} \rho_{13}\sigma \\ \rho_{23}\sigma \end{pmatrix}$.

Truncated Bivariate Probit with Endogenous Regressor

The full likelihood function is

$$\log L_n(\theta) = \sum_{i=1}^{n} \{I(y_{i1}=1, y_{i2}=1)\log l_{i1}(\theta) + I(y_{i1}=1, y_{i2}=0)\log l_{i2}(\theta) + I(y_{i1}=0)\log l_{i3}(\theta)\}$$

In the maximum likelihood estimation, ρ_{12}, ρ_{13}, ρ_{23} and σ are not directly estimated. Directly estimated is a transformation of these parameters, $\log\sigma$ for σ and $\text{atanh}\rho = \frac{1}{2}\log\left(\frac{1+\rho}{1-\rho}\right)$ for ρ. We have $\rho = \frac{-1+\exp(2\text{atanh}\rho)}{1+\exp(2\text{atanh}\rho)}$. The parameter space of the transformed variable is unrestricted. The same transformation is used by the Stata routine "heckman".

Return

Full Results: Financial Management

Truncated Bivariate Probit, Endogenous Withdrawal- Marginal Effects

	HECM	Default	Withdrawal
Property taxes/income	0.1214***	0.0337***	-0.2036***
FICO credit score	0.0005***	-0.0002***	-0.0002***
Available revolving credit	-0.0001	-0.0003***	-0.0003***
No revolving credit	-0.0423***	0.0157***	-0.0044
Mortgage past due	-0.0373***	0.0155***	-0.0283***
Tax lien or judgment	-0.0335***	0.0111***	0.0143**
Hispanic	-0.0119	0.0149***	0.0238***
Race, white	0.0602***	-0.0069*	0.0053
Race, black	-0.0644***	0.0114***	0.0391***
Unmarried male	0.0623***	0.0158***	0.0353***
Unmarried female	0.1271***	0.0047*	0.0162***
Age, youngest member	0.0193***	-0.0014	0.0084**

*** p<0.01, ** p<0.05, *p<0.1

Probit estimates reported as conditional marginal effects (default) and selection marginal effects (HECM). Robust standard errors in parentheses.

- A 100 point increase in credit score is associated with a 2.3 percentage point decrease in default rate.
- Prior tax liens associated with 1.1 percentage point increase in default rate
- Illiquidity; no revolving credit associated with 1.57 percentage point increase
- Minority borrowers' default rates are about 2 percentage points higher than non-minority borrowers.

Full Results: Loan Characteristics

Truncated Bivariate Probit, Endogenous Withdrawal-Marginal Effects

	HECM	Default	Withdrawal
Initial withdrawal %		0.0620***	
Estimated net IPL	0.0005***		
Excess home value	-0.0003***		
Mortgage payments	-0.0221***		
Actual IPL			-0.0001***
Home debt/IPL			0.3270***
Fixed rate policy			0.0554***
Constant	-3.6216***	-0.4787	0.4805**
State Fixed Effects	Y	Y	Y
Year Fixed Effects	Y	N	Y
Rho (HECM, Default)	0.0313		
Rho (HECM, Withdrawal)	0.4486***		
Rho (Default, Withdrawal)	0.0492		

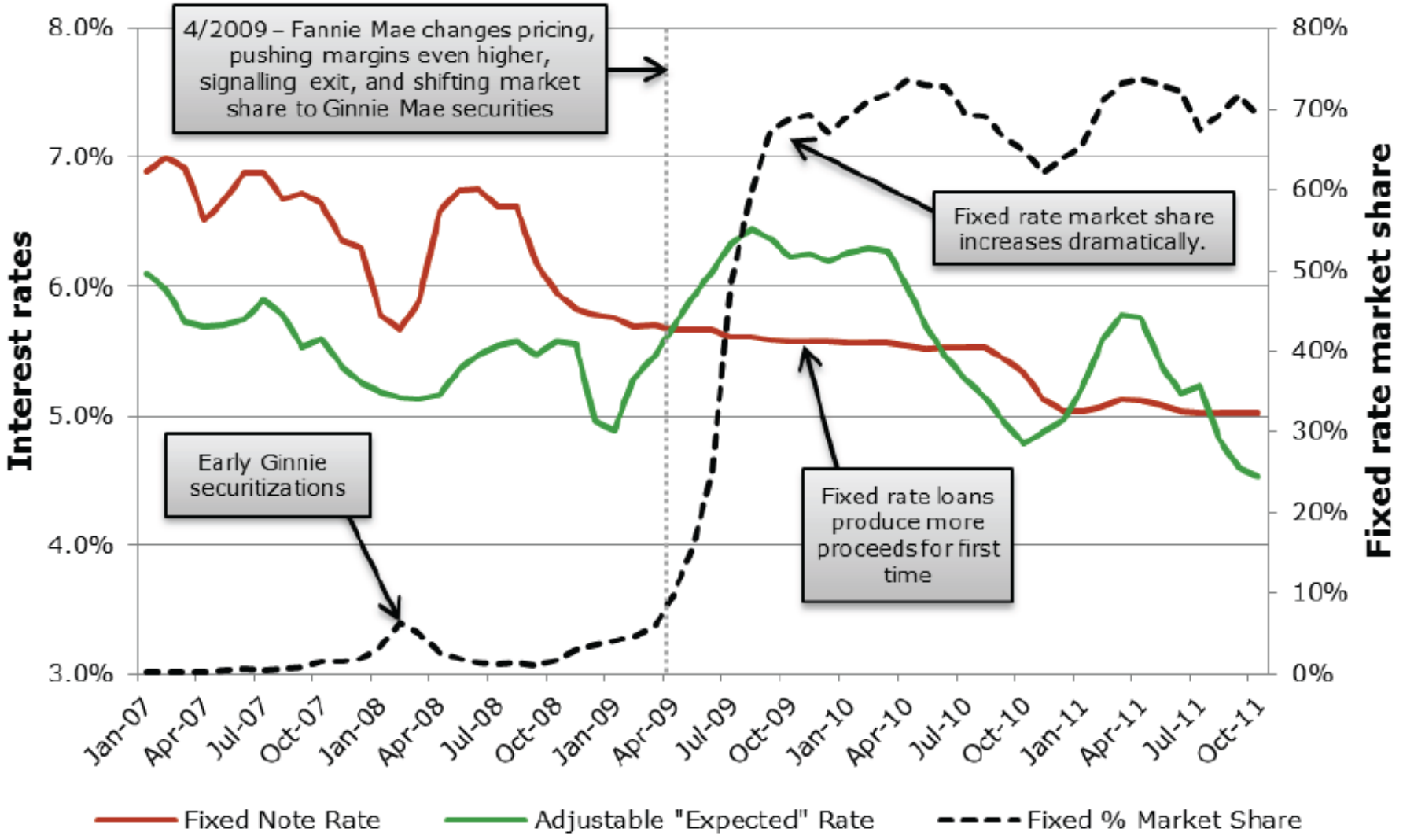
*** p<0.01, ** p<0.05, * p<0.1

Probit estimates reported as conditional marginal effects (default) and selection marginal effects (HECM). Robust standard errors in parentheses.

- A 10 percentage point increase in the initial withdrawal is associated with a .62 percentage point increase in the default rate.
- The fixed rate policy variable (withdrawal equation) is associated with a 5.5 percentage point higher up-front withdrawal.
- The correlation of errors (Rho) between take-up and withdrawal is statistically significant

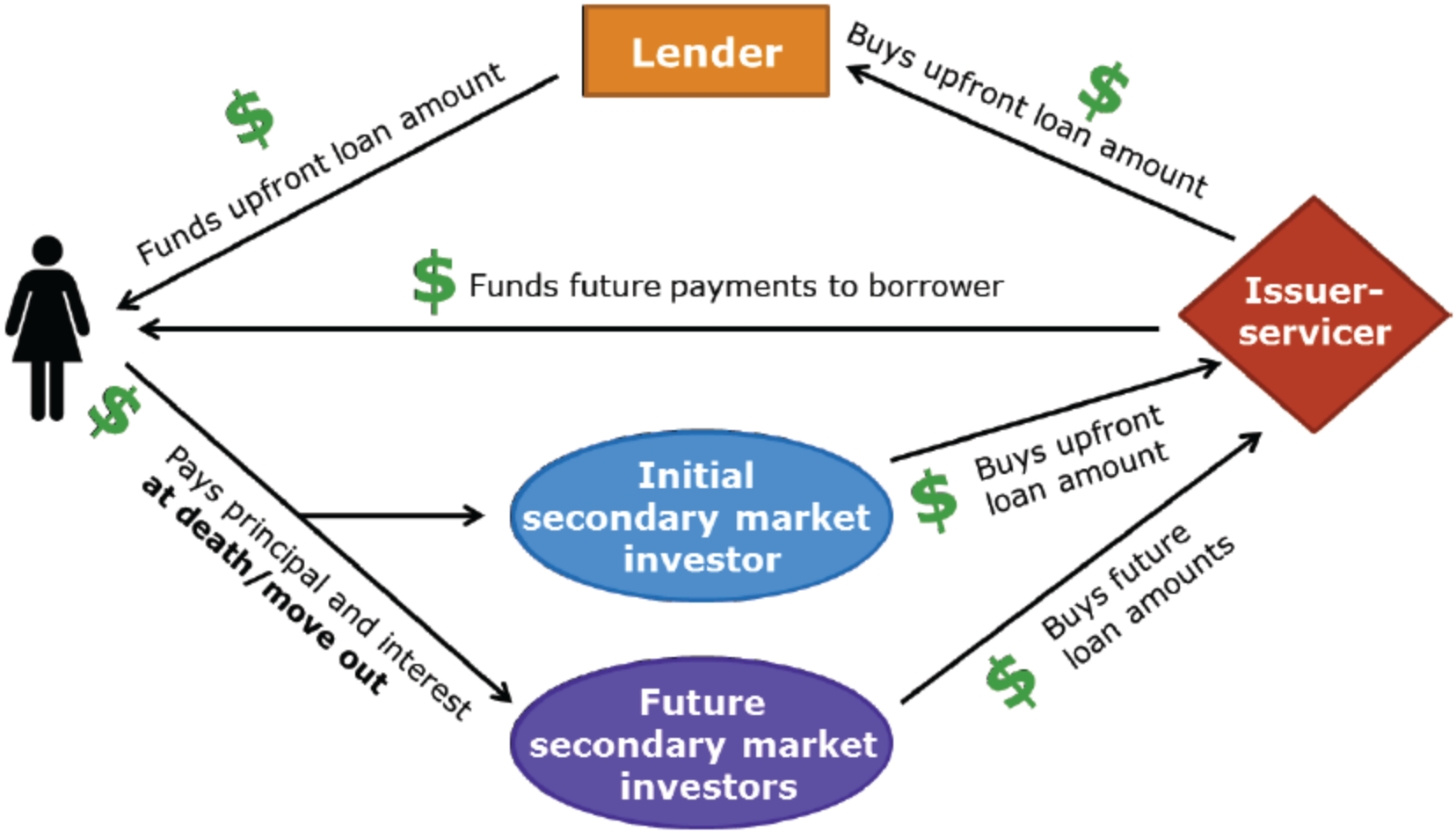
Return

Figure 38: Interest rates and fixed-rate market share



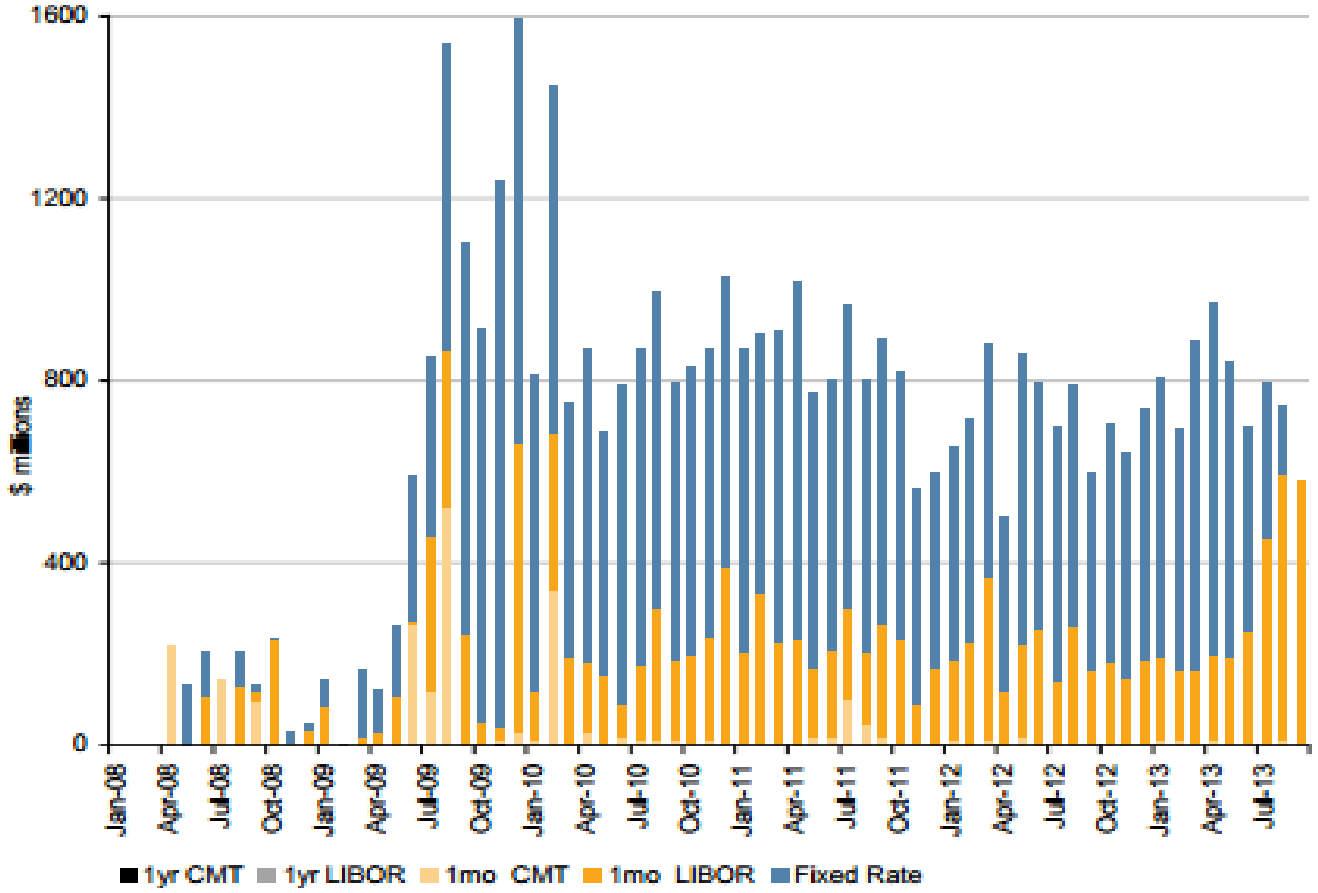
Source: CFPB 2012

Figure 36: Ginnie Mae securitization model



Source: CFPB 2012

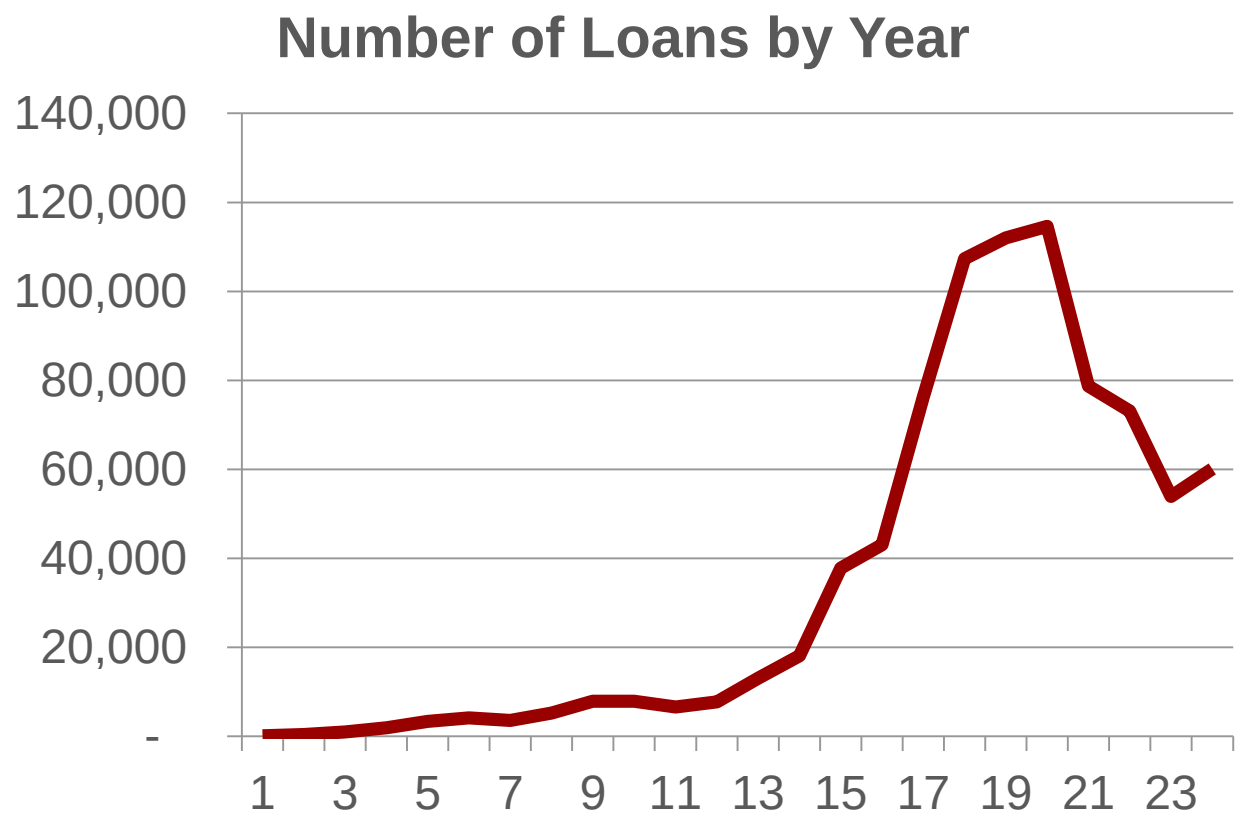
Time Series: GN HMBS Issuance



Source: Ginnie Mae, CPRCDR, RBS

http://www.ginniemae.gov/doing_business_with_ginniemae/issuer_resources/ginnienet/NewIssuerTrainingPresentations/20131122_HMBS_Panel.pdf

Take-Up of HECMs



Source: Author's calculations from HUD HECM data