Modeling the Subsidy Rate for Federal Single-Family Mortgage Insurance Programs

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Objective

- In preparing its baseline projections of the federal budget, CBO estimates the budgetary costs of programs that insure single-family mortgages.

- To estimate those costs, CBO models the programs' subsidy rates.
  - The subsidy rate measures the difference between the value of a loan guarantee and any fees received by the guarantor as a percentage of the original unpaid principal balance.
  - The budgetary cost is equal to the product of the original unpaid principal balance and the subsidy rate.

Federal Single-Family Mortgage Insurance Programs

- Several programs insure single-family mortgages:
  - The Federal Housing Administration (FHA);
  - Government-sponsored enterprises (GSEs) Fannie Mae and Freddie Mac, which CBO treats as government entities;
  - The Department of Veterans Affairs (VA); and
  - The Rural Housing Service (RHS).

Federal Mortgage Insurance

- FHA, the GSEs, VA, and RHS insure mortgages made by private lenders against borrower default.
  - The insurers receive up-front and annual fees in exchange.
  - The terms of the insurance make those mortgages less costly for borrowers than privately insured mortgages.

- Fees, which are set by the insurers, and insurance claims determine subsidy rates and, in turn, federal costs.

- Insured mortgages are pooled into mortgage-backed securities (MBSs), which are sold to investors.
  - MBSs are more liquid than the underlying mortgages.

Basis of Estimates

- CBO estimates the subsidy rate of federal single-family mortgage insurance programs on one or both of two present-value accrual bases:
  - A Federal Credit Reform Act (FCRA) basis, which reflects probabilities of default and other events that affect payments. Cash flows are discounted using interest rates on Treasury securities.
  - A fair-value basis, which additionally accounts for market risk. Cash flows are discounted at rates based on market prices (or approximations, when market prices are not available).

- GSE subsidy rates are calculated on a fair-value basis.

- FHA, VA, and RHS subsidy rates are calculated on a FCRA basis. Supplemental fair-value estimates are also calculated, in part, to facilitate comparisons with GSE subsidy rates and budgetary costs.

CBO

CBO's Modeling Approach for FHA and the GSEs

- CBO's models for FHA and the GSEs capture how changes in the mortgage market and in macroeconomic conditions affect mortgage performance. The models' inputs include:
    - Home price projections,
    - Interest rate projections,
    - Unemployment rate projections, and
    - Total mortgage originations in the market, insurers' market shares, and mortgage characteristics.

- The model estimations are based on FHA's and the GSEs' reported data on mortgage performance from 2000 to 2015.

- VA and RHS subsidy rates are estimated using a different process, based in part on the estimates provided by the Administration in the Federal Credit Supplement.

CBO's Modeling Approach for FHA and the GSEs (Continued)

- CBO uses a stochastic simulation of 1,000 economic scenarios to generate path-specific projections of
    - Defaults,
    - Prepayments, and
    - Losses given default (severity).

- CBO estimates subsidy rates by computing path-specific cash flows and applying the appropriate discount rates.

Statistical Models for FHA and the GSEs

	Prepayment Model	**Default Model**	**Severity Model**
Objective	Predict the probability of voluntary prepayment depending on borrower, mortgage, and market characteristics	Predict the probability of default depending on borrower, mortgage, and market characteristics	Predict losses in the event of a default depending on borrower, mortgage, and market characteristics
Key Inputs			
Borrower characteristics	Credit score Debt-to-income ratio	Credit score Debt-to-income ratio	Credit score
Mortgage characteristics	Loan age Loan size Loan-to-value ratio Property type Occupancy type Loan purpose (purchase, refinance) Refinance incentive	Loan age Loan size Loan-to-value ratio Property type Occupancy type Loan purpose (purchase, refinance) Refinance incentive	Loan age Loan type Loan-to-value ratios (current and original) Property type Occupancy type Mortgage insurance coverage
Market characteristics	Unemployment rate	Unemployment rate	Foreclosure laws

Cash Flow Estimation for FHA and the GSEs

- For each fiscal year, CBO estimates the characteristics of the mortgages that federal insurers will guarantee.

- For FHA and the GSEs, those mortgages are aggregated in representative groups, or "bins."
  - For each fiscal year, there are approximately 75 bins.
  - Each bin is weighted to represent a portion of borrowers, ranging from less than 1 percent to greater than 20 percent.
  - Borrowers are assigned to bins on the basis of their credit scores and their mortgages' loan-to-value ratios.

Cash Flow Estimation for FHA and the GSEs (Continued)

- Each bin is run through the statistical models using a combination of quarterly interest rates, unemployment rates, and home price changes to generate quarterly principal and interest (P&I) payments, voluntary prepayments, defaults, and losses given a default.

- Quarterly cash flows are used to calculate the components of the subsidy rate (see the following slides) and are aggregated across simulations and bins.
  - For each bin, the cash flows of all simulations are averaged.
  - For each fiscal year, a weighted average of those bin-level results reflects total federal subsidy rates.

Subsidy Rate Calculation for FHA and the GSEs

- Loan guarantees shield MBS investors from credit risk.

- In the event of a borrower's default,
  - The holder of an MBS receives P&I payments, voluntary prepayments, and the full value of the defaulted principal.
  - By contrast, the holder of whole loans receives P&I payments, voluntary prepayments, and any recoveries from defaulted principal.

- Thus, the value of a loan guarantee is calculated as the difference between the value of a security without credit risk (MBS) and the value of securities with credit risk (whole loans).

- The subsidy rate is calculated as the difference between the value of the loan guarantee and any fees received by the guarantor, expressed as a percentage of the loan amounts guaranteed.
  - Negative subsidy rates indicate that the federal guarantor's expected income from fees is greater than the expected cost of the guarantee.

Subsidy Rate Calculation: Example

Component Expressed as a percentage of the loan amount guaranteed	FCRA	Fair-Value
Value of MBS Present value of P&I payments (including defaults) and voluntary prepayments, discounted at the Treasury rate	114.3	114.3
Value of Whole Loans Present value of P&I payments, voluntary prepayments, and recoveries from defaulted principal, discounted at the Treasury rate (FCRA) or the Treasury rate plus a risk premium (fair-value)	113.2	108.2
Value of Guarantee Value of an MBS minus value of whole loans	1.1	6.1
Value of Fees Present value of fees paid to guarantor, discounted at the Treasury rate (FCRA) or the Treasury rate plus a risk premium (fair-value)	2.1	2.0
Subsidy Rate Value of guarantee minus value of fees paid to the guarantor	**−1.0**	**+4.1**

Model Inputs

Mortgage rate: 4.00%; fees paid to guarantor: 0.25%; annual prepayments: 5.00%; annual defaults: 0.50%; severity (loss given default): 25.00%; Treasury rate: 2.00%; risk premium: 0.50%

This example excludes compensation paid to mortgage servicers and compensation required by mortgage investors to bear prepayment risk, which CBO incorporates into its estimates of FHA and GSE costs.

GSE Statistical Models: Prepayment and Default

Variable	Value	Default Coefficient	Prepayment Coefficient
Age (Calendar year quarters)	1–8	0.3129	0.0917
	9–16	0.0341	-0.0916
	17–24	-0.0026	-0.0153
	25–40	0.0088	-0.0361
	40–120	-	-
Refinance Incentive (Percentage points)	Less than -1	-	-
	-1–0	-	0.2219
	0–1	-	1.5329
	1–2	-	0.4861
	2–3	-	0.2914
	Greater than 3	-	-
Current Loan-to-Value Ratio (Percent)	0–60	0.0641	-0.0070
	60–70	0.0539	-0.0090
	70–85	0.0471	-0.0271
	85–95	0.0566	-0.0327
	Greater than 95	0.0189	-0.0127
Credit Score	300–680	-0.0040	0.0031
	680–720	-0.0081	0.0025
	720–750	-0.0096	0.0026
	750–780	-0.0177	0.0002
	780–900	-0.0111	-0.0057

Values are multinomial logit coefficients estimated using loan-level data reported by Fannie Mae and Freddie Mac. The estimation sample consists of mortgages that originated between calendar years 2000 and 2012, tracked through the first six months of 2015. All variables shown in this table are modeled as spline functions. Coefficients may change with future baselines.

GSE Statistical Models: Prepayment and Default (Continued)

Variable	Default Coefficient	Prepayment Coefficient
Relative Loan Size (Proportion)	-0.1491	0.6355
Debt-to-Income Ratio (Percent)	0.0134	-0.0024
Debt-to-Income Ratio Missing	0.6597	-0.0568
Condominium	0.0764	-0.0038
Duplex	0.1026	-0.3629
Planned Unit Development	0.0381	-0.0182
Second Home	0.0037	-0.2407
Investment Property	0.3490	-0.3814
Refinance, No Cash Out	0.3225	-0.0311
Refinance, Cash Out	0.3096	-0.1682
Note Rate Spread (Percentage point)	0.4945	0.5857
State Unemployment Rate (Percentage point)	0.0968	-0.0721
2nd Quarter Calendar Year	-0.0744	0.1306
3rd Quarter Calendar Year	0.0418	0.1547
4th Quarter Calendar Year	0.1614	0.0301
Constant	-11.7163	-6.1472

Values are multinomial logit coefficients estimated using loan-level data reported by Fannie Mae and Freddie Mac. The estimation sample consists of mortgages that originated between calendar years 2000 and 2012, tracked through the first six months of 2015. For missing debt-to-income ratios, borrowers' debt or income was not reported. Coefficients may change with future baselines.

GSE Statistical Models: Severity

Variable	Severity Coefficient
Age (Quarters)	0.0085
Mortgage Insurance Amount (Percent)	-0.0090
Current Loan-to-Value Ratio (Percent)	0.0049
Original Loan-to-Value Ratio (Percent)	0.0011
Relative Loan Size (Fraction)	-0.2225
Credit Score	-0.0003
Condominium	-0.0204
Duplex	0.1228
Planned Unit Development	-0.0703
Other Property Type	0.0323
Second Home	0.0338
Investment Property	0.0760
Refinance, Cash Out	0.0987
Refinance, No Cash Out	0.0700
Judicial Foreclosure State	0.0131
Nonjudicial Foreclosure State	-0.1161
Deficiency Judgment State	-0.0085
Constant	0.2287

Values are ordinary least squared coefficients estimated using loan-level data reported by Fannie Mae and Freddie Mac. The estimation sample consists of mortgages that originated between calendar years 2000 and 2012, tracked through the first six months of 2015. Quarters are for calendar years. Coefficients may change with future baselines.

GSE Mortgage Data for 2018

Borrower and Mortgage Characteristics

Variable	Mean	Minimum	Maximum
Credit Score	752	625	824
Debt-to-Income Ratio	34	4	50
Loan-to-Value Ratio	77	14	97

Values were estimated using loan-level data reported by Fannie Mae and Freddie Mac.

GSE Mortgage Data for 2018 (Continued)

Shares of Mortgages by Occupancy and Property Type

Occupancy Type	Percent Share
Primary Residence	86
Investment Property	10
Second Home	4

Property Type	Percent Share
Single-Family Home	72
Planned Unit Development	25
Duplex	3

Values were estimated using loan-level data reported by Fannie Mae and Freddie Mac.

About This Document

These slides were prepared to enhance the transparency of the work of the Congressional Budget Office and to encourage external review of that work. In keeping with CBO's mandate to provide objective, impartial analysis, this document makes no recommendations.

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