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How CBO Estimates the Market Risk of Federal Credit Programs

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Abstract

Market risk is the component of financial risk that remains even after investors have diversified their portfolios as much as possible. Investors demand additional compensation to take on market risk. In that way, they can earn more than the return on Treasury securities, which are regarded as risk free, after netting out the average cost of default. The Congressional Budget Office supplements its formal cost estimates, which do not include the cost of market risk, with fair-value estimates, which include that cost. Because the fair-value cost of credit programs includes market risk, it can differ substantially from the official budgetary cost of such programs, which is determined in accordance with the Federal Credit Reform Act of 1990.

In this report, CBO describes how it estimates the cost of market risk in its fair-value estimates of credit programs. CBO uses different data sources and methods for different types of loans:

- **Housing and real estate loans**. CBO estimates a risk premium using market prices for private mortgage insurance and credit-risk-transfer securities, interest rate spreads, and other market information.
- **Student loans and other consumer loans**. CBO estimates market risk as a multiple of the loans' expected default losses, using the pricing of securities backed by private consumer and student loans and making a separate adjustment for income-driven repayment plans; and
- **Commercial loans**. CBO estimates their market risk as a multiple of their expected default losses, which are based on the pricing of corporate bonds.

CBO's current method for estimating the fair value of student, consumer, and commercial loans adjusts projected cash flows for market risk and then discounts them to the present using the yields on Treasury securities. That method represents a refinement of CBO's previous method, in which the agency relied more heavily on adjusting discount rates instead of cash flows to incorporate market risk. In the past, CBO discounted the future cash flows of most credit programs using a rate that was equal to the Treasury interest rate plus a risk premium. Now, CBO only applies the adjusted-discount-rate method to housing and real estate loans.

Keywords: government policy, uncertainty, risk premiums, federal credit programs, fair value, discounting, estimation methods, market risk

JEL Classification: G10, G12, G18, H50, H81, H83

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Introduction

The federal government provides credit assistance to individuals and businesses through direct loans and loan guarantees. To assess the budgetary effects of federal credit programs, the Congressional Budget Office estimates the lifetime costs of new loans and loan guarantees that are expected to be issued each year. The lifetime cost of a government program—also referred to as the subsidy cost—is calculated as the initial loan disbursement minus the present value of its future cash flows. (A present value is a single number that expresses the flow of current and future payments or income in terms of an equivalent lump sum paid or received at a specified time. A present value depends on the rate of interest, or discount rate, used to translate a cash flow in a future year into current dollars.)

CBO uses two approaches to estimate the lifetime costs of federal credit programs.[1] The first approach is to discount expected future cash flows by the yields on Treasury securities of similar maturities as prescribed by section 502(5)(E) of the Federal Credit Reform Act of 1990 (FCRA).[2] The second approach (hereafter the fair-value approach) incorporates market risk, which is a component of financial risk related to macroeconomic conditions such as productivity and employment.

This paper describes the methods and data that CBO uses to estimate the cost of market risk for three categories of federal credit programs:

- Housing and real estate loans,
- Student loans and other consumer loans, and
- Commercial loans.

CBO estimates the cost of market risk in those categories on the basis of the characteristics of each program, such as its default rate, loan maturity, or the percentage of a loan it guarantees, using data on how private investors price similar risks. For housing and real estate loans, CBO estimates the cost of market risk using the adjusted-discount-rate method. That method discounts projected cash flows at rates that include compensation for market risk consistent with the way the program would be priced in a competitive market. Those rates are equal to the yields on Treasury securities of corresponding maturities plus a risk premium. The risk premium compensates investors for taking on market risk.[3] (An alternative approach that relies on options

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[1] For the most recent annual report, see Congressional Budget Office, *Estimates of the Cost of Federal Credit Programs in 2022* (October 2021),www.cbo.gov/publication/57412.

[2] P.L. 101-508 (codified at 2 U.S.C. §661a(5)(E) (2018)).

[3] For further discussion, see Congressional Budget Office, *How CBO Produces Fair-Value Estimates of the Cost of Federal Credit Programs: A Primer* (July 2018), www.cbo.gov/publication/53886.

pricing to estimate the fair-value cost of mortgage programs with more complicated risk exposures is discussed in Appendix A).

For student loans and other consumer loans, CBO estimates the cost of market risk as a multiple of the expected cost of default, which it bases on the pricing of securities backed by private consumer and student loans. The multiple is equal to the ratio of the risk premium of a loan to the loss rate of the loan. For commercial loans, CBO also estimates the cost of market risk as a multiple of the loss rate, but its estimates of those multiples are based on the prices of corporate bonds. In using that method, known as the multiple-of-losses method, to estimate the fair value of credit programs, the projected amounts of default and recovery in cash flows are multiplied by a factor (called a multiple) such that market risk is directly incorporated in cash flows.

The multiple-of-losses method estimates fair-value subsidy costs by adjusting projected cash flows and then discounting them using the yields on Treasury securities.[4] The method of adjusting cash flows represents a refinement that will make estimates more accurate, particularly when applied to loans with longer maturities. Adjusting risk premiums and adjusting cash flows based on a multiple are two ways of approximating market prices. The choice between the two is a question of accuracy. The multiple-loss method better fits the data for federal student, consumer, and commercial loans and is likely to be more accurate when extrapolated to longer maturities (see Appendix B).

Market Risk in Housing and Real Estate Loans

The federal government supports housing finance by guaranteeing home mortgages and by backing government-sponsored enterprises that take on the risk of mortgage default. The government directly guarantees mortgages through the Federal Housing Administration's (FHA's) mutual mortgage insurance program and the Department of Veterans Affairs' (VA's) mortgage guarantee program. The government also guarantees mortgages through many smaller programs at the Department of Housing and Urban Development and the Department of Agriculture.

The federal government also indirectly supports mortgage markets through its sponsorship of Fannie Mae, Freddie Mac, and the Federal Home Loan Bank system, which are private entities with a government charter (they are also known as government-sponsored enterprises, or GSEs). Although they are private companies, CBO currently treats Fannie Mae and Freddie Mac as government entities in the budget because the two entities were placed in conservatorship by

[4] For more discussion, see Congressional Budget Office, *Fair-Value Cost Estimation and Government Cash Flow: Working Paper 2021-05* (April 2021), www.cbo.gov/publication/57062.

their federal regulator in 2008. As conservator, the federal government effectively controls Fannie Mae and Freddie Mac and the warrants and preferred shares held by the Treasury.

The net cost of a federal mortgage program depends on the rate at which borrowers in those programs default on their mortgages, the amount that can be recovered if default takes place, the speed at which borrowers repay their mortgages, and the fees collected in exchange for the government's guarantee. Those default and prepayment rates in turn depend on the economy. Borrowers tend to default at lower rates when house prices are rising and unemployment is low, and they tend to default at higher rates when house prices are falling and unemployment is high.

Analytic Methods

CBO estimates the fair value of housing and real estate loans and loan guarantees by adding a risk premium to the discount rates used to calculate the present value of cash flows. CBO bases the risk premium for each federal mortgage guarantee program on the characteristics of the mortgages and the nature of the guarantee, using a mix of market and loan performance data. CBO estimates the premiums that would be charged on FHA and VA lending using the rates that private mortgage insurers charge (subtracting expected losses and administrative costs) to borrowers with similar characteristics and levels of down payment, and then adjusting for the amount of loss that FHA and VA are likely to experience. For the two GSEs, Fannie Mae and Freddie Mac, CBO considers a variety of sources of information in determining the appropriate adjustment to discount rates. Those include private mortgage insurance pricing, the pricing of credit risk transfers, the difference between the rates on loans that are too large to be eligible for purchase by the GSEs and those that they can purchase, bunching of lending at the conforming limit, and the lack of significant fully private lending in the conforming market. (The conforming loan limit is the maximum mortgage amount that Fannie Mae and Freddie Mac will purchase or guarantee.)

FHA. CBO's method to estimate the fair value of FHA guarantees uses data from private mortgage insurance (PMI) with adjustments for differences between the exposure of government agencies and private mortgage insurers, and for administrative costs. That premium is given by the following formula:

$$\text{RiskPrem}_{\text{FHA}} = \text{Prem}_{\text{PMI}} \times \text{Scaling Factor} - \text{AdminCost} - \text{Expected Losses}$$

where $\text{RiskPrem}_{\text{FHA}}$ is the risk premium for FHA's loans and Prem_{PMI} is the premium that private mortgage insurers charge for the same type of mortgage. CBO takes the premium for PMI and increases it to account for the fact that FHA covers the entire mortgage and PMI coverage is subject to limits. CBO then subtracts out other factors that might contribute to premiums, such as administrative costs and the expected cost of default, to isolate the premium for market risk. PMI premiums are the best measure of the fair value of mortgage risks because those insurers are fully private and do not benefit from direct government backing. The interest rates charged on

most mortgages are influenced by government guarantees and the backing of Fannie Mae and Freddie Mac.

Fannie Mae and Freddie Mac. To estimate the risk premium for Fannie Mae and Freddie Mac, CBO considers PMI prices in combination with other sources of data. The prices of credit-risk-transfer (CRT) securities can be used to infer an implied fair value of Fannie Mae and Freddie Mac.[5] CRT securities shift some of the income and credit risk of a pool of mortgage loans to bond investors. CRT securities pay investors a spread over risk-free rates in exchange for taking on some of the risk of losses that the GSEs experience on their guarantees. The interest rates charged to mortgages that are too large to qualify for purchase by Fannie Mae and Freddie Mac (called jumbo loans) also can shed light on the fair value of guarantees. The difference between those rates and the rates charged on mortgages that qualify for GSE purchase is called the "jumbo-conforming" spread. It is commonly used to infer the effect of the government's sponsorship of Fannie Mae and Freddie Mac on mortgage rates. However, jumbo rates are heavily influenced by the lesser liquidity of those loans and by differences in the default and prepayment behavior of borrowers with large balances.

In CBO's assessment, Fannie Mae's and Freddie Mac's mortgage guarantees convey a small subsidy, and the estimated risk premium for them reflects that assessment. Although the price of CRT securities might suggest that Fannie Mae and Freddie Mac charge a fee that fully compensates them for the fair-value cost of their guarantees, fully private lenders have not entered the conforming market to any significant degree.[6] That lack of competition suggests that the GSEs charge less than a private lender would. In addition, the behavior of borrowers suggests that they still receive a subsidy from the GSEs.

Borrowers appear to make some effort to ensure that their loans qualify to be purchased by Fannie Mae and Freddie Mac, as can be observed in the clustering of loans at the conforming loan limit.[7] Many more loans are made at or right below the conforming loan limit than right above that limit, suggesting that borrowers reduce their loan balance to qualify for purchase by Fannie Mae and Freddie Mac. If borrowers are making some effort, the reason is most likely

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[5] See Andrew Davidson, Alex Levin, and Harry Lijia Qin, "Risk Neutralization of Agency Credit Model, Relative Value and Implied G-Fee," *Quantitative Perspectives* (October 2016), www.ad-co.com/quantitative-perspectives. Fannie Mae suspended use of CRTs at the start of the 2020–2021 coronavirus pandemic, in the first quarter of 2020. Freddie Mac continues to issue CRTs. If only one GSE continued to issue CRTs rather than both, CRTs would become less useful as a measure of market risk.

[6] See "Housing Finance at a Glance: A Monthly Chartbook," *Housing Finance Policy Center* (September 2021), https://tinyurl.com/4wjv7358. (PDF, 1 MB)

[7] See Lynn M. Fisher, Mike Fratantoni, Stephen D. Oliner, and Tobias Peter, *Jumbo Rates Below Conforming Rates: When Did This Happen and Why?* AEI Economic Policy Working Paper Series (August 2020), https://tinyurl.com/4s8jwb2y.

either because they perceive there to be a lower cost to those loans, or because banks and mortgage brokers are steering them toward those mortgages.

Results

CBO's estimated premiums for housing guarantee programs range from 37 basis points for Fannie Mae and Freddie Mac to 90 basis points for FHA (see Table 1).[8] For other housing and real estate programs with a full guarantee, CBO adjusts the discount rate by an amount equal to the estimated risk premium for FHA. For programs with a partial guarantee or a default rate lower than FHA's, the discount rate is adjusted by a portion of that risk premium. The share of the risk premium for full guarantees applied to those programs depends on the partial guarantee percentage and the default rate.

For example, the guarantee percentage for VA's mortgage insurance program ranges from 25 percent to 50 percent and is a function of the mortgage amount.[9] VA loans have consistently had lower default rates than FHA loans. As of 2020, the rate of cumulative lifetime defaults for loans guaranteed in 2012 was 3.0 percent for VA and 3.6 percent for FHA, and it was also lower for loans guaranteed in 2004 and 2010. CBO projects that the default costs for the loans VA guarantees in 2022 will be less than half the default costs of FHA's loans, partly because of lower projected default rates and partly because of the more limited guarantee. For VA's program, CBO estimates a risk premium equal to 40 basis points by adjusting the risk premium of 90 basis points for FHA to account for the partial guarantee and lower default rate of VA loans.

Based on data from the Office of Management and Budget, CBO estimates that projected default costs vary significantly in different programs but are on average lower for multifamily mortgage guarantees and other housing and real estate programs than CBO's projections for FHA's guarantees of single-family mortgages.[10]

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[8] A basis point is equal to 1/100th of 1 percent.

[9] See Congressional Budget Office, *The Role of the Department of Veterans Affairs in the Single-Family Mortgage Market* (September 2021), www.cbo.gov/publication/57024.

[10] See Office of Management and Budget, *Budget of the U.S. Government, Fiscal Year 2022: Credit Supplement* (May 2021), www.govinfo.gov/app/details/BUDGET-2022-FCS.

Table 1.

Estimates of the Risk Premium for Housing and Real Estate Loans, Fiscal Year 2022

Program	Risk Premium (Basis points)
Mutual Mortgage Insurance fund (Federal Housing Administration)	90
Fannie Mae and Freddie Mac	37
Department of Veterans Affairs	40
Other Housing and Real Estate Programs	60–90

Data source: Congressional Budget Office.

Federal fiscal years run from October 1 to September 30 and are designated by the calendar year in which they end.

Limitations

Like other models, the ones employed in this approach represent a simplified representation of reality and may not capture all factors determining the fair value of government credit programs. The approach relies on an analysis of private market data, such as CRTs and PMI contracts, to estimate the fair-value cost of government guarantee programs. It is unclear how much those prices reflect factors that are unrelated to the credit risk of government guarantee programs because of the regulatory environment in which insurers of private mortgages operate. The model is also most appropriate for measuring the price of market risk associated with relatively simple mortgage guarantees and is not as useful for relatively complex risks, such as those that might arise when the government covers excess losses on a portfolio of mortgages. For more complex exposures, CBO complements its analysis by using an options-pricing approach to estimate the fair value of mortgage obligations (see Appendix A).[11]

Market Risk in Student Loans and Other Consumer Loans

The Department of Education provides direct loans to students through three types of student loans: subsidized Stafford loans (which are available to undergraduate students), unsubsidized Stafford loans (which are available to undergraduate and graduate students), and PLUS loans (which are available to parents of certain undergraduate students and to graduate students).[12] In

[11] Options-pricing models were designed to estimate the value of a financial options, which give their holder the right, but not the obligation to buy or sell an asset. Many obligations such as mortgage guarantees are equivalent to financial options, and their value can be estimated using those same techniques.

[12] For further detail on student loans, see Congressional Budget Office, *The Volume and Repayment of Federal Student Loans:1995 to 2017* (November 2020), www.cbo.gov/publication/56706.

most cases, those loans are secured only by a person's income, without recourse to the borrower's other assets.

The federal government engages in a few other forms of lending to individuals. For example, the State Department provides emergency repatriation loans to destitute Americans abroad who are unable to finance their return to the United States. For those and other consumer lending programs, CBO accounts for market risk using the method described in this section.

Consumer lending may be evaluated using data from either the primary or secondary markets. The primary markets lend directly to consumers, and the rates charged will often vary significantly depending on the level of competition and the borrower's need for funds. For example, a student who requires funds for tuition may be rate-insensitive (meaning that the student will accept any interest rate on a loan that provides the necessary funds) and thus a lender may charge more than is required for the risk it assumes, particularly when competition is limited. In contrast, the secondary markets provide greater price discovery about the rates that competitive investors require as securities are bought and sold, although the lack of a deep secondary market may limit the amount of inference.

Analytic Methods

CBO estimates the cost of market risk as a multiple of the expected cost of default, which is based on the pricing of securities backed by private consumer and student loans. CBO estimates the risk premium for those private assets and then calculates a loss multiple equal to the ratio of those risk premiums to the expected loss rates of the same assets. To estimate the cost of market risk for federal credit programs, CBO applies that multiple to the losses of those programs. The result represents the present value of the cost of market risk. (In Appendix A, CBO discusses why the multiple-of-losses approach is preferable to the adjusted-discount-rate approach in estimating the fair value of some credit programs.)

CBO estimates fair-value subsidies for student loans in income-driven repayment (IDR) plans separately from student loans in fixed-payment repayment plans. IDR plans tie required payments to borrowers' incomes and provide loan forgiveness after a certain period, typically 20 to 25 years. Those plans involve more market risk than fixed-payment plans because of the formulas used to calculate required payments and because borrowers may be eligible to have

their unpaid balances forgiven.[13] When the economy performs poorly, borrowers' earnings are more likely to decrease, lowering the required payments. Those reduced payments will eventually lead to greater loan forgiveness. (That additional risk is partly offset because borrowers in IDR plans are less likely than borrowers in fixed-payment plans to default on their loans.) To develop an adjustment for IDR plans, CBO applied methods from academic studies that estimate the financial value of required payments that are a function of future wages.[14]

Those studies developed methods to adjust projections of future wages on the basis of their relationship with stock prices. Although wages and stock prices can diverge in the short term, they tend to follow similar paths over long periods. Stocks earn an excess return—known as the equity premium—over Treasury bonds because of the systematic relationship between the stock market and the economy. The strong long-term relationship between stock prices and wages implies that a fraction of the equity premium should be used to adjust the projection of future wages that is included in the projection of required payments. CBO estimates that fraction to be 3/8.

For fair-value estimates of student loans, CBO first considers current estimates of the equity risk premium and the relationship between stock prices and wages and adjusts the growth rate of future wages in its projections of required payments for borrowers in IDR plans. That adjustment is equal to 2 percent when applied to an equity risk premium of 5.5 percent. Second, the projected default and recovery amounts for all borrowers (using the adjusted cash flows for borrowers in IDR plans) are adjusted for market risk using a loss multiple that is based on the pricing of securities in the private sector.

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[13] Borrowers of subsidized and unsubsidized Stafford loans and PLUS loans for graduate students are eligible for all IDR plans, the most generous of which require annual payments of 10 percent of the borrowers' discretionary income and forgive outstanding balances after 20 years. The balances of PLUS loans to parents can be consolidated to make them eligible for repayment through a less generous IDR plan, which requires annual payments of 20 percent of discretionary income and forgives outstanding balances after 25 years. In addition, the Public Service Loan Forgiveness program forgives the outstanding balance on direct loans—those received under the William D. Ford Federal Direct Loan Program—after borrowers have made 10 years of payments under a qualifying repayment plan, such as an IDR plan, while they have been employed full time in the public sector.

[14] See Congressional Budget Office, "Including Market Risk in Estimates of the Budgetary Effects of Changing the Federal Retirement System for Civilian Workers" (supplemental material for *Options for Changing the Retirement System for Federal Civilian Workers,* October 2017), www.cbo.gov/publication/53003; Mark Huggett and Greg Kaplan, "How Large Is the Stock Component of Human Capital?" *Review of Economic Dynamics,* vol. 22 (October 2016), pp. 21–51, https://doi.org/10.1016/j.red.2016.06.002; John Geanokoplos and Stephen P. Zeldes, "Market Valuation of Accrued Social Security Benefits," in Deborah Lucas, ed., *Measuring and Managing Federal Financial Risk* (University of Chicago Press, 2010), pp. 213–233, http://papers.nber.org/books/luca07-1; Luca Benzoni, Pierre Collin-Dufresne, and Robert S. Goldstein, "Portfolio Choice Over the Life-Cycle When the Stock and Labor Markets Are Cointegrated," *The Journal of Finance,* vol. 62, no. 5 (October 2007), pp. 2123–2167, https://doi.org/10.1111/j.1540-6261.2007.01271.x; and Deborah Lucas and Stephen P. Zeldes, "Valuing and Hedging Defined Benefit Pension Obligations—The Role of Stocks Revisited" (draft, Columbia Business School, September 2006), https://tinyurl.com/xm4ue6jf.

CBO analyzed secondary market data for the issuance of asset-backed securities (ABS) between January 2018 and April 2021 to estimate the risk premium for student loans and other consumer loans.[15] Banks and other institutions finance consumer and student loans partly by packaging them into securities and selling them to investors and partly with their own debt and equity. CBO estimates the value of private-sector consumer and student loans by observing the returns that investors require to purchase those securities and combining those data with estimates of the return on debt and equity retained by the sponsor. CBO's fair-value estimates of federal consumer and student loans are based on private-sector loans with similar characteristics.

The ABS data include subprime auto loans, credit card receivables, private student loans, and other personal loans. For each transaction, CBO uses rating reports to determine the amount of the collateral funded by ABS investors and estimated that the remainder was funded equally by debt and equity investments from the sponsor.[16] (CBO estimates that the average debt-to-assets ratio is about 50 percent for consumer finance firms.)

ABS transactions are divided into pieces called tranches—each with a specific coupon rate, maturity, credit rating, and risk profile. Credit rating agencies rate the individual tranches of the ABS and typically provide details for the underlying collateral—for example, the loss rate and maturity. The estimated risk premium for the ABS is a weighted average of the risk premium applicable to each funding source: ABS investors and the debt and equity investment of the ABS sponsor.[17] For each funding source, the risk premium is equal to the sum of that source's ABS collateral losses plus its expected return. The details for each funding source are discussed below (see Table 2 for a direct comparison of the components of the risk premium applicable to all funding sources).

[15] Data for ABS transactions are available through Finsight.

[16] Ratings reports are available from multiple rating agencies, including DBRS Morningstar, Moody's Investors Service, and S&P Global Ratings.

[17] A sponsor is defined as a person who organizes and initiates an asset-based securities transaction by selling or transferring assets, either directly or indirectly, including through an affiliate, to the issuing entity. See Asset Backed Securities (Regulation AB), 17 CFR §229.1101 (2012).

Table 2.

Components of the Risk Premium for Asset-Backed Securities, by Source of Funding

	Component		
Source	**Collateral Losses**	**Expected Return**	**Risk Premium**
Investors	The default intensity estimated from historical ABS default probabilities.	The difference between the risk premium and the ABS collateral losses.	The spread between the weighted average coupon rate for the ABS and the rate on 3-month Treasury securities, minus a liquidity premium of 5 basis points.
Debt	The expected annual loss on ABS collateral, net of investors' estimated losses, per dollar of debt and equity investment.	The estimated risk premium for the credit rating of the ABS sponsor.	The sum of ABS collateral losses and the expected return.
Equity	The expected annual loss on ABS collateral, net of investors' estimated losses, per dollar of debt and equity investment.	The equity beta of the ABS sponsor multiplied by the equity risk premium for the total market.	The sum of ABS collateral losses and the expected return.

Data source: Congressional Budget Office, using data from DBRS Morningstar, Moody's Investors Service, and S&P Global Ratings.

ABS Investors. The risk premium is equal to the spread between the weighted-average coupon rate for the ABS and the rate on three-month Treasury securities, minus a liquidity premium of 5 basis points. The securities are highly liquid, and the estimated liquidity premium is approximately equal to that for corporate bonds rated AAA and AA. (Analytic methods to estimate the liquidity premium for corporate bonds are discussed in the section "Risk Premium for Commercial Loans.") To estimate the risk premium for the debt and equity investment of the ABS sponsor, CBO needs to estimate the amount of collateral funded by ABS investors and the expected losses on that collateral.

The amount of the collateral funded by ABS investors is estimated net of the target overcollateralization (and in some cases, the reserve or liquidity accounts) for the transaction. Overcollateralization is a form of credit enhancement that protects the ABS investors and occurs when the value of the assets in the pool is greater than the value of the ABS. Section 941(b) of the Dodd-Frank Wall Street Reform and Consumer Protection Act requires that sponsors of a securitization transaction retain no less than 5 percent of the credit risk of the assets collateralizing any ABS transaction.[18] After the minimum retention requirement has been applied, CBO estimates that the average portion of the collateral funded by ABS investors in its

[18] P.L. 111-203 (codified at 15 U.S.C. §78o-11(c)(1) (2018)).

sample is about 80 percent for subprime auto loans, 90 percent for student loans and personal loans, and 95 percent for credit card receivables.

The expected loss rate on ABS collateral is obtained from the rating report for each transaction. CBO uses historical cumulative default rates for ABS and the maturity of the underlying collateral to estimate a default intensity for the collateral losses borne by ABS investors.[19] (The concept of default intensity is explained in more detail in the section "Risk Premium for Commercial Loans.") CBO estimates that the expected losses borne by ABS investors is small, reaching a maximum weighted average of 1 percent for the ABS in its sample. The remainder of the expected losses for ABS is borne by the debt and equity investments for the ABS.

Debt and Equity Investment. The risk premium for debt and equity investment is equal to the expected losses on ABS collateral (net of the estimated losses borne by ABS investors), plus an expected return for each type of investment.

The expected return for the debt investment is equal to the risk premium for the credit rating of the ABS sponsor**.** If a credit rating is unavailable for the sponsor, CBO applies the risk premium for a sponsor with a bond rating of BBB on the Standard & Poor's scale because BBB is the lowest rating applicable to investment-grade creditworthiness. (Analytic methods to estimate risk premium by credit rating are discussed in the section "Risk Premium for Commercial Loans.")

The expected return on the equity investment is equal to the "equity beta" of the ABS sponsor, multiplied by the "equity premium" for the total market. The equity beta is a measure of the sensitivity of the sponsor's expected return to that of the overall market, and the equity premium is the expected excess return from investing in the stock market over the return from investing in Treasury securities. (CBO uses the S&P 500 total return index as its measure for the overall market.) CBO estimates that the 5-year equity beta for consumer finance firms is equal to 0.9 for 2018, 1.1 for 2019, and 1.3 for 2020 and 2021. Similarly, the estimate of the 15-year equity premium is 4.7 percent for 2018, 5.3 percent for 2019, 6.0 percent for 2020, and 5.5 percent 2021.

Results

The risk premium for ABS is a weighted average of the risk premium for each funding source (see discussion in box on page 23 for an example). CBO estimates the loss multiple for ABS as the risk premium divided by the annual loss rate; that multiple represents the additional premium investors require for bearing the risk of loss. ABS data are grouped into four risk categories (very low, low, moderate, and high) on the basis of the expected loss rate identified in the rating

[19] For more detail, see S&P Global Ratings, Default, Transition, and Recovery: 2019 Annual Global Structured Finance Default Study and Rating Transition Study (June 29, 2020).

reports. The estimated risk premiums and loss multiples for consumer loans are an average of all ABS data over the sample period for each risk category (see Table 3).

Table 3.

Estimates of the Risk Premium for Student Loans and Other Consumer Loans, Fiscal Year 2022

Risk Category	Loss Rate (Percent)	Risk Premium (Basis points)	Loss Multiple
	Student Loans		
Very Low	0.1 to 5.0	147	8.5
Low	5.1 to 7.0	224	4.5
Moderate	7.1 to 10.0	242	3.4
High	10.1 to 15.0	256	2.5
	Other Consumer Loans		
Very Low	0.1 to 5	143	6.3
Low	5.1 to 10.0	255	2.2
Moderate	10.1 to 20.0	403	1.5
High	> 20.0	606	1.4

Data source: Congressional Budget Office.

Federal fiscal years run from October 1 to September 30 and are designated by the calendar year in which they end.

CBO uses the student loan model to estimate the risk premium and loss multiple for each loan program using various combinations of risk categories that vary by default rates, recovery rates, repayment plans, and other parameters specific to the program or to legislative proposals.[20] Therefore, though the risk premiums and loss multiples estimated in that model are consistent with those from ABS data for student loans, the overall estimate for a specific loan program may be a combination of more than one of the ABS risk categories.

Limitations

CBO uses ABS data from the secondary market to estimate the risk premium and amount of collateral retained by the sponsor. The estimates of the overcollateralization and the required

[20] For the most recent estimates by student loan type, see Congressional Budget Office, *Estimates of the Cost of Federal Credit Programs in 2022* (October 2021), www.cbo.gov/publication/57412.

return on that collateral are not directly observed in the market, and thus may be too high or too low. Although primary market data could provide more insight into pricing, those data have significant idiosyncratic variation and are difficult to obtain with sufficient detail to estimate the risk premium.

Additionally, federal student loans differ from consumer loans provided by private institutions because the Department of Education has strong collection abilities and, in most cases, the U.S. Bankruptcy Code does not provide for the discharge of federal indebtedness in the event of personal bankruptcy.[21] Those collection abilities include wage garnishment and offsets to tax refunds and other government benefits, such as Social Security, and result in a higher recovery rate than would be experienced in the private sector. However, the nature of market risk is not affected by collection methods: Defaults are still more likely in bad economic scenarios than in good. The multiple-of-losses method produces a lower estimate of the cost of market risk for a lender with access to the government's special collection tools than for a lender without such access.

Market Risk in Commercial Loans

The federal government provides direct loans and loan guarantees to commercial entities—that is, businesses. Data are not available to assess the credit quality of an individual borrower, but extensive data are available from rating agencies about the historical default experience of corporate bonds with a particular rating. The rating agencies conduct annual corporate default studies using fixed pools (which those agencies refer to as "static" pools) of bonds issued by corporate entities—including industrial firms, financial institutions, utilities, and insurance companies—grouped by initial ratings category. That method allows default rates to be calculated over long horizons and accounts for changes in ratings over time.

For each credit rating, CBO estimates the risk premium from the traded prices of bonds with that rating, and then uses it in combination with the expected loss rates of those bonds to calculate a loss multiple. CBO approximates a credit rating for each commercial lending program on the basis of the loans' maturity and estimated loss rate and applies the loss multiple associated with that credit rating to the programs expected losses to estimate its cost of market risk.

Analytic Methods

CBO estimates the risk premium for each credit rating using data from the interest rates on corporate bonds. Investors charge interest to corporate borrowers over and above risk-free rates to compensate for the average cost of default and the lesser liquidity of corporate bonds, and as

[21] For further detail, see 11 U.S.C. §523(a)(8) (2018).

compensation for market risk. CBO estimates the component for market risk by subtracting the costs of default losses and liquidity from corporate bond spreads.

To measure corporate bond yields, CBO uses indexes that cover the overall market. Aggregate index data are not subject to the idiosyncratic dynamics of the constituent bonds and therefore allow for more robust estimates. The data set includes Bloomberg Barclays U.S. corporate bond indexes: five indexes correspond to the credit ratings of AAA, AA, A, BBB, and BB and two indexes represent aggregate rating categories for investment-grade bonds (equal to or above BBB) and speculative grade bonds (below BBB) The data set contains monthly observations of the weighted-average yield and weighted-average life reported for each bond index from January 1996 to December 2020. CBO produced similar estimates with weekly data.

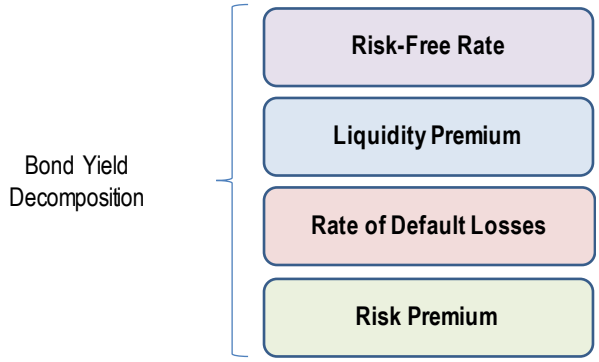
CBO deconstructs the corporate bond yield beginning with an estimate of the spread over risk-free Treasury securities, and then estimates the liquidity and default loss components of the spread.[22] The liquidity premium represents compensation for the risk that a bond may not be quickly converted to cash without loss of value. Similarly, the default premium represents

[22] CBO estimates market risk premiums for commercial loans using the analytic method described in John Hull, Mirela Predescu, and Alan White, "Bond Prices, Default Probabilities and Risk Premiums," *Journal of Credit Risk,* vol. 1, no. 2 (Spring 2005), https://dx.doi.org/10.21314/JCR.2005.007.

compensation for the expected cost of default.[23] The residual amount is the risk premium, which is the component of financial risk that remains even after investors have diversified their portfolios as much as possible (see Figure 1).

Figure 1.

Decomposition of Corporate Bond Yields



The corporate bond yield is decomposed into four components: the risk-free rate, the liquidity premium, the rate of default losses, and the risk premium. The liquidity premium is compensation for the risk that a bond may not be quickly converted into cash without loss of value, and the rate of default losses represents the expected default cost. The risk premium compensates investors for taking on market risk, which is a component of financial risk related to macroeconomic conditions, such as productivity and employment, that cannot be diversified away.

Bond Yield Spread. CBO estimates the bond yield spread by subtracting the swap rate on Treasury securities for the corresponding duration from the corporate bond yield. (The swap rate is a fixed interest rate for an agreed period, generally referred to as maturity, at which major global banks borrow U.S. currency from each other.) CBO uses LIBOR (London Interbank Offered Rate) swap rates to represent the risk-free yields. Most market participants currently view LIBOR as risk free because major global banks rarely default, and the obligations are secured by collateral. However, LIBOR is scheduled to be phased out by December 2021, and financial markets are transitioning to the use of alternative reference rates that are considered risk free (that is, free of interbank credit risk). (The Secured Overnight Funding Rate (SOFR) is the alternative reference rate that is set to replace LIBOR in the United States, and CBO will

[23] The expected cash flows from a loan or loan guarantee include expected defaults and recoveries. Therefore, when estimating the fair value of the loan or loan guarantee, the market risk premium used to discount those cash flows must be net of any default premium.

transition to SOFR swap rates as needed in the future.)[24] In general, the bond yield spread increases with the riskiness of the bond, and the spread is largely explained by compensation for default and market risk.

Liquidity Premium. CBO does not independently estimate the liquidity premium, characterized as the compensation required for the risk that a bond cannot be quickly converted into cash, but uses academic studies to adjust its estimate of the risk premium. The liquidity of a bond can be measured in multiple ways on the basis of its transaction costs, market depth, and trading activity. A combination of the measures is sometimes constructed in the literature to find a robust and reliable measure for liquidity. The bid-ask spread—a measure of transaction costs—is the difference between the price paid by an urgent buyer and received by an urgent seller. A bond is highly liquid when there are many buyers and sellers of a bond and the bid-ask spread is low. Market depth refers to the market's ability to process large buy and sell orders without affecting the price of a security; the greater the market depth, the greater the liquidity and the less likely it is that large trades will affect the price of a security. Finally, markets have greater liquidity when turnover is high. Market turnover indicates how much trading activity took place on a given day and can be measured in both dollar value and volume terms.

A widely used method to estimate the liquidity premium—the compensation required for the risk that a bond cannot be quickly converted into cash—is to determine the portion of bond spreads explained by a liquidity measure such as the bid-ask spread. CBO reviews academic studies that use the bid-ask spread to estimate the liquidity premium, and the agency's current estimates are based on the results presented in a paper by Wu that confirms and expands the findings of similar studies.[25] That paper estimates the liquidity premium as a fraction of the bond yield spread for three credit rating categories (A and above, BBB, and speculative grade) during several subperiods between 2004 and 2019. The author finds that, although the bid-ask spread has narrowed, the liquidity premium has increased since the financial crisis of 2008 to 2009 as a

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[24] For a discussion of the changes to LIBOR and its impact on financial markets, see Randal K. Quarles, "Goodbye to All That: The End of LIBOR" (speech given at the Structured Finance Association Conference, Las Vegas, Nev., October 5, 2021), www.federalreserve.gov/newsevents/speech/quarles20211005a.htm; Alternative Reference Rates Committee, "Frequently Asked Questions," *New York Federal Reserve* (April 27, 2021), www.newyorkfed.org/arrc/publications; Nicholas Burgess, "Libor Benchmark Reform: An Overview of Libor Changes and Its Impact on Yield Curves, Pricing and Risk" (rev. January 3, 2020), https://dx.doi.org/10.2139/ssrn.3479833; Pimco, "From Libor to SOFR: Demystifying the USD Swap Discounting Transition" (October 2020), https://tinyurl.com/y46rf9bk; and Andreas Schrimpf and Vladyslav Sushko, "Beyond Libor: A Primer on the New Benchmark Rates," *BIS Quarterly Review* (March 5, 2019), https://ssrn.com/abstract=3348186..

[25] Botao Wu, "Increasing Corporate Bond Liquidity Premium and Post-Crisis Regulations," NYU Stern School of Business (April 1, 2020), https://dx.doi.org/10.2139/ssrn.3613379. For additional discussion of the methodology, see Jens Dick-Nielsen, Peter Feldhütter, and David Lando, "Corporate Bond Liquidity Before and After the Onset of the Subprime Crisis," *Journal of Financial Economics*, vol. 103, no. 3 (March 2012), pp. 471–492, https://dx.doi.org/10.1016/j.jfinec0.2011.10.009.

result of the tighter capital requirements introduced by various regulations.[26] Earlier studies had similar findings for changes in the liquidity premium during financial crises, but generally did not report estimates of the liquidity premium over a longer horizon or for multiple credit ratings consistent with CBO's data set.[27] For all years in its sample, CBO estimates an average liquidity premium of about 10 basis points for bonds rated A and above, 20 basis points for bond rated BBB, and 110 basis points for speculative-grade bonds (those with credit ratings below BBB).

A disadvantage to estimating the liquidity premium as a fraction of the bond yield spread is that the method may overestimate the liquidity premium because of its inability to fully disentangle default risk. Some authors address that issue by comparing the yields of bonds with similar characteristics and issued by the same firm.[28] However, that type of analysis is not widely accepted in the literature because it relies on such a small sample.

Rate of Default Losses. CBO estimates the average rate of default losses for each observation on the basis of the loan's credit rating and maturity. That estimate is derived from an estimate of the default intensity over T years for a bond of rating i (denoted by $h_{T,i}$) and represents the probability of default per year by borrowers who have not previously defaulted—that is, the probability of default for a bond with rating i that is T years old. The default intensity is calculated from the cumulative default rate over T years for a bond with rating i (denoted by $d_{T,i}$):[29]

$$h_{T,i} = -\frac{1}{T}\ln\left(1 - d_{T,i}\right)$$

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[26] Banking regulations in the United States have tightened as a result of the Dodd-Frank Wall Street Reform and Consumer Protection Act and revised standards of the Basel Committee on Banking Supervision. The Basel Committee is responsible for ensuring financial stability by coordinating regulation and supervision of internationally active banks.

[27] For examples, see Cassandre Anténor-Habazac, Georges Dionne, and Sahar Guesmi, "Cyclical Variations in Liquidity Risk of Corporate Bonds" (May 2, 2018), http://dx.doi.org/10.2139/ssrn.3179772; Viral V. Acharya, Yakov Amihud, and Sreedhar T. Bharath, "Liquidity Risk of Corporate Bond Returns: Conditional Approach," *Journal of Financial Economics*, vol. 110, no. 2 (November 2013), pp. 358–386, https://dx.doi.org/10.1016/j.jfinec0.2013.08.002; NS Nils Friewald Rainer Jankowitsch, and Marti G. Subrahmanyam, "Illiquidity or Credit Deterioration: A Study of Liquidity in the U.S. Corporate Bond Market During Financial Crises," *Journal of Financial Economics*, vol 105, no. 1 (July 2012), https://dx.doi.org/10.1016/j.jfinec0.2012.02.001.

[28] For example, see Jean Helwege, Jing-Zhi Huang, and Yuan Wang, "Liquidity Effects in Corporate Bond Spreads," *Journal of Banking and Finance*, vol. 45 (August 2014), pp. 105–116, https://dx.doi.org/10.1016/j.jbankfin.2013.08.018.

[29] CBO uses the global corporate average cumulative default rates published by S&P Global Ratings. Those default rates are based on the experience of fixed pools of corporate bonds grouped by initial ratings category from 1981 to 2019. For further discussion, see S&P Global Ratings, "2019 Annual U.S. Corporate Default and Rating Transition Study" (June 2020).

The rate of expected default losses is estimated by multiplying the default intensity by 1 minus the expected recovery rate. CBO estimates a recovery rate of 40 percent in all credit rating categories on the basis of data reported by Moody's for senior unsecured bond recovery rates between 1983 and 2020.[30]

Risk Premium. The risk premium for each observation is the residual amount after subtracting the liquidity premium and the expected default loss rate from the bond yield spread. CBO also estimates a loss multiple for each credit rating equal to the bond yield spread net of the liquidity premium, divided by the expected default loss rate. Although adjustments are made for default and liquidity, it is impossible to fully separate those risks from market risk. Additionally, CBO's estimates of market risk implicitly include other unidentified sources of risk, such as inflation risk, maturity risk, and prepayment risk.

Results

The individual components of the bond yield spread (the liquidity premium, expected default loss rate, and risk premium) may be highly variable in a given year (and at specific points in time) because they fluctuate with macroeconomic conditions. To disentangle short-term fluctuations from aggregate risk measures, CBO uses historical default probabilities and averages across time in estimating the risk premium applicable to commercial loan programs. CBO's analysis concludes the following on the basis of the decomposition of the bond yield spread over time for bonds with investment-grade credit quality (see Figure 2):

- **The risk premium fluctuates over time.** The risk premium responds to changes in macroeconomic conditions, both at specific points in time and across time. In estimating the cost of federal credit programs, it is important to consider expectations over the life of the loan. Those expectations incorporate short-term fluctuations (as exhibited during crisis periods) and sustained shifts from regulation and market expectations.
- **The risk premium increased significantly during financial crises.** Bond yield spreads increased during the 2001–2002 and 2008–2009 financial crises, with a noticeable increase in the liquidity premium compared with the period before the crisis. Although the default premium also increased at the time (not reflected in CBO's estimates because of the use of historical default probabilities), the magnitude of the estimated risk premium significantly outweighs any changes in default expectations (nearly 15 times the default premium as estimated from historical default probabilities).
- **The risk premium has remained elevated since the 2008–2009 financial crisis.** Bond yield spreads and the risk premium have declined since 2009 but remain close to those experienced during the 2001–2002 financial crisis. That sustained upward shift in the level of

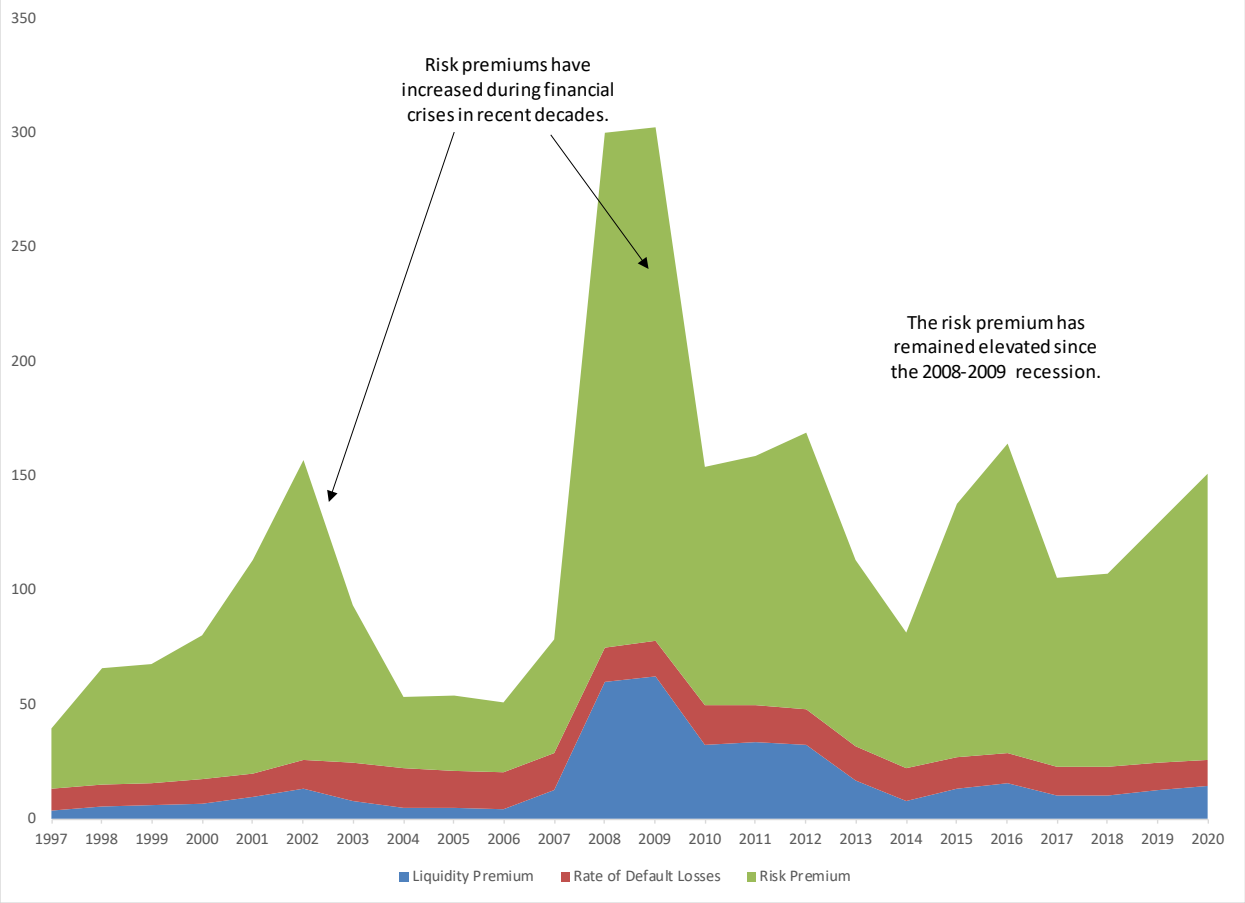
[30] For more detail, see Moody's Investors Service, "Default Trends—Global: Annual Default Study" (January 2021), Exhibit 27.

the risk premium supports the notion of placing greater weight on market experience after 2009.

Figure 2.

Decomposition of the Spread on Investment-Grade Bond Yields, 1997 to 2020

(Basis points)



Data source: Congressional Budget Office.

The liquidity premium is compensation for the risk that a bond may not be quickly converted into cash without loss of value, and the rate of default losses represents the expected default cost. The risk premium compensates investors for taking on market risk, which is a component of financial risk related to macroeconomic conditions, such as productivity and employment, that cannot be diversified away.

The risk premium and loss multiple for each credit rating are equal to a weighted average over time. CBO assigns a weight of 1.75 percent to each crisis year (2001, 2002, 2008, and 2009) on the basis of the annual probability of a moderate financial crisis. The remaining weight (93 percent) is allocated with a weight of two-thirds to the period after the recession of 2008 to 2009, and one-third to the period before the recession, with equal distribution among the non-crisis years in each period. CBO evaluated three additional weighting options: a weight of 4 percent assigned to each crisis year, equal weights assigned to all years, and no weight assigned to crisis

years. The risk premium estimates vary slightly, and CBO's selected weighting scheme falls in the middle of those other sensitivity options.

CBO's estimates are based on historical probabilities of default from 1981 to 2019 and are interpolated for some speculative-grade credit ratings (see Table 4). For sensitivity analysis, weighted-average estimates are also presented using the raw data and historical default probabilities over a longer period (1970 to 2020) that includes additional years with a high number of defaults.[31] When the longer time period is used to estimate historical probabilities of default, the estimated risk premium is about the same for investment-grade bonds (BBB and above) but lower for speculative-grade bonds (BBB− or lower) as a result of a higher default premium for speculative grade bonds.

Estimates of the risk premium and loss multiple for bonds rated below B− are based on an index of speculative grade bonds. Reliable data were not available for bonds rated B, and CBO estimates the risk premium and loss multiple for that rating to be equal to the value for the BB rating plus 40 percent of the difference between the BBB and below B− ratings.

[31] Historical default probabilities from 1970 to 2020 are reported in Moody's Investors Service, "Default Trends—Global: Annual Default Study" (January 2021).

Table 4.

Estimates of the Risk Premium for Commercial Loans by Credit Rating, Fiscal Year 2022

	Probability of Default 1981 to 2019		Probability of Default 1970 to 2020	
Credit Rating	**Risk Premium (Basis points)**	**Loss Multiple**	**Risk Premium (Basis points)**	**Loss Multiple**
AAA	39	11.6	40	14.3
AA	48	11.2	47	11.6
A	72	8.6	69	6.6
BBB	113	5.4	111	4.9
BB	148	2.4	132	2.1
B	165	2.2	141	2.1
Below B-	192	2.0	155	2.2

Data source: Congressional Budget Office.

Federal fiscal years run from October 1 to September 30 and are designated by the calendar year in which they end.

Reliable data were not available for B-rated bonds. CBO estimated the risk premium and loss multiple for that rating to be equal to the value for BB-rated bonds plus 40 percent of the difference between the ratings for BBB bonds and the ratings for bonds rated lower than B−.

CBO assigns a credit rating to commercial lending programs on the basis of the programs' maturity and expected loss rate. Using that credit rating, CBO then assigns a risk premium and loss multiple. Because risk premiums are estimated only for the rating categories available from the selected Bloomberg Barclays indexes, CBO further interpolates between those amounts to infer risk premiums for intermediate rating categories. For example, CBO uses a linear relationship between the estimated risk premiums for the A-rated and BBB-rated securities to infer risk premiums for the A-minus and BBB-plus categories.

Limitations

There are at least two potential drawbacks to the method CBO used to estimate the risk premium. First, investors' expectations of default rates may differ from the historical default rates. To estimate the relationship between bond yield spreads and expected default costs, CBO assumed that investors in corporate bonds expect default rates that are equal to historical averages for corporations with the same rating as the issuer of the bond. For any given bond and in any given year, investors' expectations of default costs may differ from historical averages; therefore, CBO's estimated risk premium and loss multiple for a given observation may be too high or too low. CBO expects that those errors will average out to zero, but they may not if investors' expectations of future default rates are systematically different from the historical average.

Second, the estimated risk premium and loss multiple may contain elements other than the risk associated with macroeconomic conditions. In CBO's assessment, the premium associated with those other factors is not substantial; therefore, the estimated risk premium and loss multiple are reasonable measures of market risk to use in estimating the lifetime costs of commercial loans under the fair-value approach. In its annual fair-value update and other analyses of specific programs, CBO provides a sensitivity analysis for its fair-value estimates using higher and lower estimates of market risk.

Box. Using an Asset-Backed Security to Estimate Market Risk

To see how the risk premium and loss multiple can be estimated, consider an asset-backed security (ABS) transaction for a pool of student loans with 20 percent overcollateralization, with the result that investors in the ABS fund 80 percent of the transaction. (Overcollateralization is a form of credit enhancement that protects the investors and occurs when the value of the assets in the pool is greater than the value of the ABS.) In this example, the overcollateralization is funded equally by debt and equity investments from the sponsor of the ABS.[32] That funding has the following parameters:

- Expected loss on ABS collateral: 15 percent,
- Maturity: Five years,
- Weighted-average coupon rate: 100 basis points,[33]
- ABS cumulative default rate: 1 percent,
- Risk premium on debt (based on the credit rating of the sponsor): 150 basis points,
- Equity beta: 1.3, and
- Equity premium: 5.5 percent.

The three funding sources—ABS investors, debt, and equity—each have two components in their risk premium: ABS collateral losses and the expected return.

ABS Investors

The risk premium of 90 basis points (*bp*) is equal to the spread between the weighted-average coupon rate for the ABS (100 *bp*) and the rate on three-month Treasury securities (5 bp), minus a liquidity premium (5 *bp*). The ABS cumulative default rate of 1 percent equates to a default intensity of 20 *bp*, which represents the annual loss on the ABS collateral borne by ABS investors (see "Risk premium for Commercial Loans" section to see how default intensity is estimated). The expected return for ABS investors is 70 *bp*, equal to the difference between the risk premium (90 *bp*) and ABS collateral losses (20 *bp*).

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[32] A sponsor is defined as a person who organizes and initiates an asset-based securities transaction by directly or indirectly selling or transferring assets, including through an affiliate, to the issuing entity.
17 C.F.R. §229.1101(l) —2021.

[33] A basis point is equal to 1/100th of 1 percent.

Debt Investment

The ABS collateral loss for the debt and equity investments is equal to the expected annual loss on ABS collateral net of the estimated losses borne by ABS investors, per dollar of debt and equity investment:

$$\frac{\frac{15\ percent}{5\ years} - 80\ percent\ \times 20\ bp}{1 - 80\ percent} = 1{,}420\ bp$$

The expected return of 150 basis points is equal to the risk premium on debt. The risk premium is 1,570 *bp*, equal to the sum of ABS collateral losses on the ABS (1,420 *bp*) and the expected return (150 *bp*).

Equity Investment

The expected return of 715 *bp* is equal to the equity beta (1.3) times the equity premium (550 *bp*). The risk premium is 2,135 *bp*, equal to the sum of ABS collateral losses (1,420 *bp*) and the expected return (715 *bp*). The estimated risk premium for the ABS is a weighted average of the risk premium applicable to each funding source:

$$80\ percent \times 90\ bp + 10\ percent\ \times 1{,}520\ bp + 10\ percent\ \times 2{,}135\ bp = 443\ bp$$

The loss multiple is 1.5, equal to the risk premium (443 *bp*) divided by the expected annual loss on the ABS collateral (300 *bp*).

Using an Asset-Backed Security to Estimate the Risk Premium

	Source of ABS Funding			Weighted Average
	Investors	Debt	Equity	
Share of Total Funding	80	10	10	n.a.
Annual Risk Premium (Basis points)				
ABS collateral losses	20	1,420	1,420	300
Expected return	70	150	715	143
Total	90	1,570	2,135	443
Loss Multiple	n.a.	n.a.	n.a.	1.5

Data source: Congressional Budget Office.

n.a. = not applicable.

Appendix A: An Alternative Approach for Measuring the Fair Value of Complicated Mortgage Obligations

CBO adjusts the discount rate to estimate the fair value of government mortgage obligations in its annual update of the cost of federal credit programs. It bases that adjustment on the average price of private mortgage insurance (PMI) with adjustments for administrative costs and for differences between the exposure of government agencies and the exposure of private mortgage insurers. Although that approach is easy to understand and transparent, it requires CBO's judgment in cases in which the amount of risk held by the government and its private partners is divided in complicated ways. In those cases, it is not clear what fraction of market risk is taken by each party in the transaction, making it unclear how the risk premium should be divided.

For more complicated risk exposures, CBO developed an alternative approach to estimate the fair-value cost of mortgage programs that is based on options-pricing methods. That approach incorporates the cost of market risk in the cash flows instead of in the discount rate. The approach combines two statistical models. The first model estimates the relationship between house prices, unemployment rates, and interest rates over time. The second model projects the rates at which borrowers default on and repay their mortgages on the basis of those economic variables and other factors. The first model, which governs the economic variables, is called a vector auto regression (VAR) model. A VAR model is used to estimate the relationship between a set of variables and their past values as well as the values of explanatory variables. The VAR model CBO used in the alternative approach supplies projections of house price appreciation, unemployment rates, and interest rates for use in the projection of default and prepayment rates.

The second model, for projecting default and prepayment rates, is called a multinomial logit, which is a standard approach for estimating the likelihood of more than one mutually exclusive event, such as default and prepayment. The parameters of the multinomial logit—which relate the likelihood of default and prepayment to economic variables and borrower characteristics—are estimated using data from the National Mortgage Database (NMDB). The borrower characteristics include their credit score, the loan-to-value ratio of their mortgage and whether they are first-time home buyers, among other things. The NMDB is a nationally representative sample of residential mortgages in the U.S. maintained by the Federal Housing Finance Agency and Consumer Financial Protection Bureau. The NMDB's data include loan characteristics, the location of the home, and borrower data such as income and first-time-home-buyer status, and monthly reports on whether the loans default or repayments are made. The data include loans purchased by Fannie Mae and Freddie Mac between 2000 and 2014. The NMDB data set was chosen because of its wide coverage; it includes mortgages guaranteed by all major government programs.

The approach projects default and prepayment rates under economic scenarios randomly drawn from VAR. VAR has error terms that are assumed to be normally distributed. The approach

randomly draws error terms from the normal distribution and then projects the economic scenarios using the VAR model's parameters, taking the error terms as given. CBO then estimates default and prepayment rates conditional on those economic scenarios. Given a set of default and prepayment rates, it is possible to calculate a net present value by discounting cash flows of the credit program.

To incorporate market risk into the estimate, the approach shifts the economic environment and thus the probability distribution of default and prepayment rates toward more adverse outcomes. It does so by drawing the error terms for house price growth from an adjusted probability distribution in which the average value is negative instead of zero. Under the VAR model, those lower error terms for house prices affect the projections of interest rates and unemployment rates as well as future values of house prices themselves. That process results in an adjusted set of economic scenarios which are centered on an abrupt drop in house prices, and a spike in the unemployment rate, in addition to a significant drop in interest rates.

The approach adjusts the error term for house price growth to a point at which private mortgage insurers are projected to earn zero economic profits in a process known as "calibration." The approach models the revenues and costs of private mortgage insurers to calibrate the model. The estimates of what private mortgage insurers charge are based on the published tables obtained from the MGIC Investment Corporation.[34] In principle, if there is enough competition in the PMI industry, economic profits will equal zero. Under this approach, economic profits are estimated as those that fall within the adjusted probability distribution, and the profits within the unadjusted probability distribution represent a normal return on the risk taken by the private mortgage insurers.

The adjusted probability distribution of economic scenarios, after the process of calibration, can be used to generate cash flows projections for government credit programs. Those projections of cash flows already incorporate market risk through the adjustment to the probability distribution of the error terms and therefore can be discounted using a Treasury rate to obtain a fair-value estimate. Thus, an adjusted discount rate is not needed for the fair-value calculation.

[34] For the current rate cards for mortgage insurance from MGIC, see www.mgic.com/rates/rate-cards.

Appendix B. Comparing Fair-Value Estimates Using the Adjusted-Discount-Rate Method With Estimates Using the Multiple-of-Losses Method

The lifetime cost of a loan or loan guarantee is generally described as a subsidy. It is measured by first projecting all expected future cash flows associated with a loan or loan guarantee as the average of the set of possible values and then discounting those projected cash flows to a present value on the date the loan is disbursed.[35] (Present value is a single number that expresses a flow of revenues or outlays over time in terms of an equivalent lump sum received or paid at a specific point.) The subsidy rate equals the cost divided by the amount disbursed.

In the following example, a simple direct loan with credit rating BBB and a maturity of 10 years is used to demonstrate how to calculate subsidy rates. The example has the following parameters:

- Annual interest rate on the loan: 2 percent,
- Annual rate on Treasury securities: 1.5 percent,
- Recovery rate: 40 percent,
- Risk premium: 113 basis points,[36] and
- Loss multiple: 5.4.

In Table B-1, the first calculation uses procedures required by the Federal Credit Reform Act of 1990 (FCRA) and discounts projected cash flows to the present using projected yields on Treasury securities. Two methods to calculate subsidy rates on a fair-value basis are then demonstrated. The first method discounts the projected cash flows using an adjusted discount rate. The second method adjusts the projected default and recovery cash flows and discounts those cash flows using Treasury rates.

Procedures Mandated by the Federal Credit Reform Act

Under FCRA procedures, net cash flows for a direct loan are equal to the sum of disbursements and scheduled principal and interest, minus defaulted principal and interest, plus recoveries. The annual discounted present value equals the net cash flows multiplied by the present-value factors for the corresponding year. In this example, the present-value discount factors are based on an annual interest rate of 1.5 percent. The subsidy cost is the present value of the cash flows—equal

[35] The statistical mean of a set of cash flows is the sum of each possible cash flow multiplied by the probability of its occurrence.

[36] A basis point is equal to 1/100th of 1 percent.

to the sum of the discounted present values for each year. The subsidy rate (−2.7 percent) is the subsidy amount as a percentage of the disbursement.

Fair Value: Adjusted-Discount-Rate Method

The adjusted-discount-rate method uses the same net cash flows as under FCRA procedures. In this example, the present-value factors incorporate a risk premium of 113 basis points. The adjusted present value factor is calculated as:

$$Adjusted\ Present\ Value = \frac{Present\ Value\ \ Under\ FCRA}{(1+rp)^t}$$

in which *t* is the number of years after disbursement and *rp* is the risk premium. The fair-value subsidy cost is the present value of the cash flows—in which the value in each year is equal to the product of the net cash flows and the corresponding present-value factor for that year. In this example, the fair-value subsidy rate is 7.3 percent, using a risk premium of 113 basis points.

Fair Value: Multiple-of-Losses Method

The multiple-of-losses method uses the same present-value factors required by FCRA procedures but adjusts the default and recovery amounts. In this example, the loss multiple is 5.4, and the default and recovery cash flows are equal to the product of that multiple and the projected defaults and recoveries from the FCRA cash flows. The discounted present-value cash flows are equal to the net cash flows multiplied by the same present-value factors as under FCRA procedures, and the fair-value subsidy is equal to the sum of the discounted present-value cash flows. That method results in a subsidy rate of 5.9 percent, which is close but not exactly equal to the estimate made by using the adjusted discount rate.

Implicit Discount Rate. Although there is no explicit adjustment to the discount rate under the multiple-of-losses method, an implicit risk premium can be calculated as the difference between the internal rate of return (IRR) of the loan's projected cash flows under fair value and the IRR under FCRA procedures. (The IRR is a discount rate that makes the net present value of all cash flows equal to zero.) In this example, the IRR under fair value is 2.48 percent, and the IRR under FCRA procedures is 1.5 percent. Those calculations yield an implicit adjustment to the discount rate of approximately 97 basis points under the following calculation:

$$10{,}000 \times \left(\frac{1.0248}{1.015} - 1\right) = 97$$

Accordingly, 97 basis points is the risk premium under the adjusted-discount-rate method that would yield the same subsidy rate as a multiple of 5.4 under the multiple-of-losses method.

Differences Between the Two Fair-Value Methods

Although CBO has often used the adjusted-discount-rate method for commercial loan programs, it has updated its method for those programs to estimate their cost more accurately on a fair-value basis. In its current estimates of the estimated fair-value cost of federal credit programs, CBO uses the multiple-of-losses method for all student, consumer, and commercial loans. CBO continues to use an adjusted-discount-rate approach to estimate the fair-value cost of housing and real estate programs, for which that approach produces relatively accurate estimates.

Academic theories of the pricing of assets subject to credit risk do not supply a clear answer as to which method might be the best way to translate expected losses into the cost of market risk, partly because that theory is not settled. Many academics and practitioners use the options-pricing models of Black, Scholes and Merton as a basis for their estimates, but others have offered numerous competing theories.[37] As a result, CBO does not rely on any single theory's relationship between expected losses and market risk, instead treating that question as a matter to be settled by empirical analysis.

The multiple-of-losses method is more accurate for student, consumer, and commercial credit programs, in CBO's assessment, because it better fits the observed relationship between risk premiums and expected rates of losses for private assets. In addition, the multiple-of-losses method is more sensitive to special features of federal credit programs such as very long maturities and non-standard amortization schedules. For corporate bonds, the multiple-of-losses method better replicates the observed relationship between maturity and risk premiums for different credit ratings. For example, for B-rated bonds, both risk premiums and expected loss rates decline with maturity.[38] The multiple-of-losses method generates a risk premium that matches such behavior, and the adjusted-discount-rate method does not. Under the multiple-of-losses method, the risk premium would drop as the loss rate drops because it is calculated as a multiple of the loss rate. Under the adjusted-discount-rate method, the risk premium is a constant

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[37] See Darrell Duffie and Kenneth J. Singleton, "Modeling Term Structures of Defaultable Bonds," *The Review of Financial Studies*, vol. 12, no. 4 (Special 1999), pp. 687–720, https://www.jstor.org/stable/2645962; Dilip B. Madan and Haluk Unal, "Pricing the Risks of Default," *Review of Derivatives Research*, vol. 2 (December 1998), https://doi.org/10.1007/BF01531333;; Robert Jarrow and Stuart Turnbull, "Pricing Derivatives on Financial Securities Subject to Credit Risk," *Journal of Finance*, vol. 50, no. 1 (March 1995), pp. 53–85, https://doi.org/10.2307/2329239; Francis A. Longstaff and Eduardo S. Schwartz, "A Simple Approach to Valuing Risky Fixed and Floating Rate Debt," *Journal of Finance*, vol. 50, no. 3 (July 1995), pp. 789–819, https://doi.org/10.1111/j.1540-6261.1995.tb04037.x; Fischer Black and Jon C. Cox, "Valuing Corporate Securities: Some Effects of Bond Indenture Provisions," *Journal of Finance*, vol. 31, no. 2 (May 1976), pp. 351–367, https://doi.org/10.2307/2326607; Robert C. Merton, "On the Pricing of Corporate Debt: The Risk Structure of Interest Rates," *Journal of Finance,* vol. 29, no. 2 (May 1974), pp. 449–470, https://doi.org/10.2307/2978814; and Fischer Black and Myron Scholes, "The Pricing of Options and Corporate Liabilities," *Journal of Political Economy*, vol. 81, no. 3 (May–June 1973), pp. 637–654, https://www.jstor.org/stable/1831029.

[38] See Jerome S. Fons, "Using Default Rates to Model the Term Structure of Credit Risk," *Financial Analysts Journal*, vol. 50, no. 5 (September–October 1994), pp. 25–32, https://doi.org/10.2469/faj.v50.n5.25.

and would not drop as maturity increases, leading to an overestimate of market risk for credit programs that have longer maturities with relatively high rates of default.

The improvement in accuracy is most significant for programs with very long or very short maturities. The two methods produce similar estimates for credit programs with maturities that match those of the bonds in the data set used to estimate loss multiples and risk premiums because the parameters are estimated to fit those data. The methods produce much different answers if they are applied to credit programs with maturities outside the range of that data set. The estimates of the risk premium and loss multiple for a specific credit rating are based on corporate bond data with different maturities for each index. For example, the index of A-rated corporate bonds has an average maturity of 11 years (varying from 9 to 14 years), compared with an average maturity of 12 years (varying from 10 to 14 years) for the index of BBB-rated corporate bonds. CBO's estimates of the risk premium are centered on the maturity associated with each bond index, and thus estimates under the two methods will vary with longer or shorter maturity.

For housing and real estate programs, maturities of loans and guarantees made through government programs are like those in the private sector. Therefore, the adjusted-discount-rate and multiple-of-losses methods are likely to generate similar results; therefore, CBO continues to use the adjusted-discount-rate method because it is convenient.

For example, consider a long-term program such as loans made under the Transportation Infrastructure Finance and Innovation Act. The loans have a maturity of 40 years, with interest payments deferred for 10 years and principal payments deferred for 20 years. The adjusted-discount-rate method with a risk premium of about 120 basis points results in a 14-fold increase in the default subsidy; the multiple-of-losses method estimates a 3.5-fold increase. The multiple-of-losses method weights the default and recovery cash flows at the time they are expected to occur rather than discounting those cash flows at a higher rate for many years during which payments are not scheduled to occur.

Table B-1.

Two Methods to Estimate Fair Value

Parameters and Assumptions	
Interest Rate on Loan (Percent)	2
Treasury Rate (Percent)	1.5
Recovery Rate (Percent)	40
Risk Premium (Basis points)	113
Loss Multiple	5.4

	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
Cumulative Default Rates (Percent)		0.16	0.45	0.78	1.17	1.58	1.98	2.33	2.67	3.00	3.32
FCRA Procedures											
Disbursement	100,000										
Scheduled Interest		2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000
Scheduled Principal											100,000
Defaulted Principal and Interest		-3	-9	-16	-23	-32	-40	-47	-53	-60	-3,386
Recoveries		64	116	132	156	164	160	140	136	132	128
Net cash flows	-100,000	2,061	2,107	2,116	2,133	2,132	2,120	2,093	2,083	2,072	98,742
Present-Value Discount Factors	1.0000	0.9852	0.9707	0.9563	0.9422	0.9283	0.9145	0.9010	0.8877	0.8746	0.8617
Discounted Present Value	-100,000	2,030	2,045	2,024	2,009	1,979	1,939	1,886	1,849	1,812	85,082
FCRA Subsidy	-2,657										
FCRA Subsidy Rate (Percent)	-2.7										
Fair Value: Adjusted-Discount-Rate Method											
Disbursement	100,000										
Scheduled Interest		2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000
Scheduled Principal											100,000
Defaulted Principal and Interest		-3	-9	-16	-23	-32	-40	-47	-53	-60	-3,386
Recoveries		64	116	132	156	164	160	140	136	132	128
Net cash flows	-100,000	2,061	2,107	2,116	2,133	2,132	2,120	2,093	2,083	2,072	98,742
Present-Value Discount Factors	1.0000	0.9742	0.9491	0.9246	0.9008	0.8775	0.8549	0.8329	0.8114	0.7905	0.7701
Discounted Present Value	-100,000	2,008	2,000	1,957	1,921	1,871	1,813	1,744	1,690	1,638	76,040
Fair-Value Subsidy	7,320										
Fair-Value Subsidy Rate (Percent)	7.3										
Fair Value: Multiple-of-Losses Method											
Disbursement	100,000										
Scheduled Interest		2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000
Scheduled Principal											100,000
Defaulted Principal and Interest		-17	-49	-84	-126	-171	-214	-252	-288	-324	-18,287
Recoveries		346	626	713	842	886	864	756	734	713	691
Net cash flows	-100,000	2,328	2,578	2,629	2,716	2,715	2,650	2,504	2,446	2,389	84,405
Present-Value Discount Factors	1.0000	0.9852	0.9707	0.9563	0.9422	0.9283	0.9145	0.9010	0.8877	0.8746	0.8617
Discounted Present Value	-100,000	2,294	2,502	2,514	2,559	2,520	2,424	2,256	2,171	2,089	72,729
Fair-Value Subsidy	5,941										
Fair-Value Subsidy Rate (Percent)	5.9										

Data source: Congressional Budget Office.

FCRA = Federal Credit Reform Act of 1990.