HISIM2—The Health Insurance Simulation Model Used in Preparing CBO's Spring 2019 Baseline Budget Projections

April 2019

The Role of CBO's
Health Insurance Simulation Model, HISIM2

What Is HISIM2 Used For?

HISIM2 is a new version of the model CBO uses to generate estimates of health insurance coverage and premiums for the population under age 65.

The model is used in conjunction with other models to develop baseline budget projections (which incorporate the assumption that current law generally remains the same).

It is also used to estimate the effects of proposed changes in policies that affect health insurance coverage.

What's New This Year?

To prepare its spring 2019 baseline budget projections, CBO is using new sources of data as inputs and has completely revamped the way it models consumers' and employers' behavior.

- HISIM2 incorporates new base data, including data from surveys and administrative data.

- It changes the way individuals and families choose among coverage options.

- It changes the way firms take workers' preferences into account when deciding whether to offer employment-based coverage.

How Does CBO Use Its Health Insurance Simulation Model to Develop Baseline Projections?

The process has six main steps. In the first three steps, CBO:

- Updates its health insurance simulation model at least once a year to incorporate new information, specifically:
  - The most recent administrative and survey data on enrollment and premiums;
  - Recently enacted legislation, judicial decisions, or changes in regulations; and
  - CBO's most recent macroeconomic forecast (including demographic projections).

- Projects coverage estimates through the end of the period covered by the agency's baseline budget projections and reviews the model's output.

- Adjusts the model's coverage projections using CBO's Medicaid enrollment model and separate models that analyze aspects of current law that are simplified in the health insurance simulation model.

For details, see Congressional Budget Office, *How CBO and JCT Analyze Major Proposals That Would Affect Health Insurance Coverage* (February 2018), www.cbo.gov/publication/53571.

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How Does CBO Use Its Health Insurance Simulation Model to Develop Baseline Projections? (Continued)

In the remaining three steps, CBO:

- Estimates spending for Medicaid, the Children's Health Insurance Program (CHIP), and the Basic Health Program, using models for those programs.

- Determines net costs of federal subsidies for work-related coverage and coverage through the nongroup market, as well as taxes and penalties related to coverage, using the Joint Committee on Taxation's tax models.

- Reviews final baseline budget projections and writes a report.

Data Underlying the Model

CPS Data

The microdata used by HISIM2 begin with the Current Population Survey (CPS).

- The CPS is a nationally representative survey of about 95,000 households. It provides reliable, timely, and detailed information about many of the key variables needed to model health insurance.

- Those variables include demographic and family characteristics, income, employment, the availability of employment-based insurance coverage, and self-reported health status.

Modifications to CPS Data

CBO modifies the CPS data in three ways. First, CBO edits the following variables, which are likely to have been reported with some error, so that they better match other survey and administrative data:

- The size of firms,

- Self-employment income, and

- Whether a worker's employer offers health insurance.

Modifications to CPS Data (Continued)

Second, CBO supplements the CPS with additional variables necessary for modeling people's and employers' decisions about health insurance coverage, such as:

▪ Immigration status;

▪ Capital gains;

▪ Marginal tax rates;

▪ The probability distribution of health care spending for each individual;

▪ The characteristics of an employer's potential insurance offerings for three plan types (HDHP, HMO, and PPO) and two coverage types (single and family); and

▪ Eligibility for Medicaid and CHIP.

High-deductible health plans (HDHPs) allow the use of a tax-preferred health savings account to cover expenses not paid by the plans. Health maintenance organizations (HMOs) are insurance plans in which services obtained outside a specified network of providers are not covered. Preferred provider organizations (PPOs) tend to offer wider provider networks, cover services from providers outside of their network, and limit costs through cost-sharing arrangements and a deductible.

The characteristics of an employer's potential insurance offerings are assigned on the basis of its characteristics, such as its size, the state in which it operates, and the fraction of low-wage workers in it. Those characteristics include the plan's cost-sharing requirements and premium, the employer's contribution to the premium, and (for HDHP plans) whether and how much an employer contributes to a health savings account or health reimbursement account.

Modifications to CPS Data (Continued)

Third, CBO defines various units to help model consumers' and employers' behavior.

CBO groups household members to build three types of units used to calculate income and taxes, determine eligibility for subsidies, and define the coverage choices that are available to people. Those units are called tax filing units, marketplace units, and health insurance units (HIUs).

CBO also builds a synthetic firm for each employed respondent consisting of an imputed set of coworkers whose characteristics match the actual characteristics of such an employee's coworkers. CBO assigns coworkers on the basis of the size of the worker's firm (using the agency's edited version of firm size as reported in the CPS); whether or not the firm offers health insurance; and the worker's wages, age, and state of residence.

Projecting Data Through the Entire Projection Period

After adjusting and supplementing the CPS data for a base year, CBO projects input data for each year through the end of the 11-year period covered by the agency's baseline budget projections.

CBO employs two main approaches to project population characteristics of the base-year data:

- The agency projects income, health care spending, and the characteristics of employment-based insurance offers to identify the growth patterns of those variables.

- CBO uses an optimization routine to simultaneously adjust the sample weights of people in the CPS sample during the period to match projections of population characteristics, including population growth and changes in patterns of employment.

The base year of data for CBO's spring 2019 baseline projections is 2015, and the 11-year period covered by those projections is 2019 to 2029.

Modeling Decisions by Consumers

Overview of HIUs' Behavior

What Is a Health Insurance Unit? An HIU is the decisionmaking unit in HISIM2. A single person is his or her own HIU. Otherwise, an HIU is the set of individuals who could be covered by a family plan—that is, any plan that covers two or more people—if an employer were to offer that plan.

What Decisions Do HIUs Make? An HIU collectively chooses the type of health insurance coverage in which to enroll each of its members. People within the same HIU may not be eligible for the same type of coverage and do not necessarily choose the same coverage option.

How Do HIUs Make Decisions? HIUs make decisions by maximizing utility in a random utility model. Each alternative in the choice set is assigned a probability derived from a statistical model.

HIUs' Utility

The utility of each alternative depends on the HIU's total income, health care spending (including premiums, an out-of-pocket spending distribution, and any applicable subsidies, taxes, and mandate penalties), financial risk, and unobserved factors.

- Out-of-pocket spending is determined by the health status of each member of the HIU and by the cost-sharing characteristics of the insurance plan.

- Utility is assumed to decrease as risk increases. Risk is measured as the variance in out-of-pocket spending.

Many utility function parameters are estimated by minimizing the difference between the coverage predictions from the model and coverage targets for the base year of data. (Coverage targets are CBO's preliminary estimates from individual data sources of the actual number of people with a particular coverage status.) Some parameters are set on the basis of CBO's assessment of the research literature.

HIUs' Insurance Options

HIUs select the type of insurance for each person in the unit from choices such as these:

- Employment-based coverage: single or family

- Nongroup coverage in the marketplaces: bronze, silver, or gold

- Nongroup coverage outside the marketplaces: bronze, silver, or gold

- Medicaid

- CHIP

- Medicare

- None (Uninsured)

Employment-based coverage is coverage offered by a current or former employer—either one's own or a family member's. Firms are restricted to offer only one type of plan: an HDHP, HMO, or PPO. Nongroup coverage is coverage that a person purchases directly from an insurer or through a health insurance marketplace, rather than through an employer. Plans in the nongroup market are categorized into tiers (which are named after metals) on the basis of their actuarial value (which is the percentage of total average costs for covered benefits for which a plan pays). "Bronze" plans are those with an actuarial value of 60 percent, "silver" plans are those with an actuarial value of 70 percent, and "gold" plans are those with an actuarial value of 80 percent.

Choice Sets

The set of insurance choices available to each HIU is determined by the characteristics of that HIU (for example, income and members' ages).

Single-person and multiperson HIUs have different choice sets.

The choice set of an HIU is restricted by the eligibility of its members for public insurance, subsidized marketplace insurance, and employment-based insurance.

CBO restricted the choice sets in the model to maintain as much realism as possible while keeping the model simple enough to limit the computing time that it takes to simulate coverage effects of proposed policies.

Choice Set: Single-Person HIUs

The choice set for single-person HIUs consists of alternatives that are categorized into one of five "nests."

Alternatives within the same nest are considered closer substitutes than alternatives in different nests.

Nest	Alternatives
Employment-based coverage	Employment-based coverage
Nongroup outside the marketplaces	Bronze, silver, gold
Nongroup in the marketplaces	Bronze, silver, gold
Public insurance	Medicaid, Medicare
Uninsured	Uninsured

Within the public-insurance nest, the choices between Medicaid and Medicare are mutually exclusive. CHIP is not an alternative for single-person HIUs because only children are eligible for CHIP and a child cannot be in an HIU by himself or herself.

Utility Specification: Single-Person HIUs

The utility for HIU i from alternative n, U_{in}, is the predicted value that the HIU places on the alternative, V_{in}, and an idiosyncratic unobservable component, ε_{in}, which implies a nested logit model.

$$U_{in} = \beta_1 V_{in} + \varepsilon_{in}$$

The predicted values, V_{in}, are normalized by a scaling factor β_1.

The scaling factor helps translate the value that HIUs place on a coverage alternative into dollars.

For details about the nested logit model, see Train (2009).

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Utility Specification: Single-Person HIUs (Continued)

$$V_{in} = y_i - C_{in} - E[H_{in}] - \frac{1}{2}\rho_n Var(H_{in}) + \delta_{1n}(y_i, a_i)$$

y_i is the HIU's income, and a_i is the age of the only person in HIU i.

C_{in} is the cost to HIU i of alternative n, which includes premiums and applicable individual-mandate penalties.

$E[H_{in}]$ and $Var(H_{in})$ are the expectation and variance, respectively, of HIU i's out-of-pocket health care spending for each alternative n. Out-of-pocket health care spending for the uninsured alternative is capped at a value that increases with income to capture uncompensated care and bankruptcy.

ρ_n is the coefficient of absolute risk aversion.

δ_{1n} is a utility shifter for each alternative n.

Utility Specification: Single-Person HIUs (Continued)

The last term in the value function, $\delta_{1n}(y_i, a_i)$, increases or decreases the dollar value of each type of coverage, sometimes for a particular age (a_i), income (y_i), or both.

That utility shifter measures such concepts as:

- Awareness of insurance alternatives,

- Access to insurance alternatives (including the ease of enrolling through a web portal and the ease of determining eligibility),

- Attitudes toward insurance (which may be affected, for example, by the stigma associated with public coverage), and

- Unmeasured differences in insurance alternatives, such as network size.

Utility for the Uninsured Alternative

The out-of-pocket spending for the uninsured alternative is capped at a dollar value that increases with income to reflect uncompensated care received by people without insurance and the ability to declare bankruptcy. Because of that ability, households have only limited exposure to the financial risk of medical shocks. That exposure increases with the value of assets, which generally increases with income.

The coefficient of absolute risk aversion, ρ_n, reflects how much HIUs dislike variation in their out-of-pocket spending.

- The risk aversion coefficient is set to be consistent with the existing literature.

- Coefficients estimated from data with large gains or losses are smaller than those estimated from smaller gains or losses. The decision about whether to buy insurance results in larger expected gains or losses than does the decision about how generous a plan to buy. Therefore, CBO sets the risk aversion coefficient for the uninsured alternative to be smaller than the one for the insured alternatives.

Choice Set: Multiperson HIUs

- Multiperson HIUs have a larger choice set than single-person HIUs do because different members of an HIU can have different types of coverage.

- Each alternative represents a combination of coverage types in which HIUs can enroll its members.

- Under each alternative, members of the HIU are sorted into different types of coverage on the basis of their eligibility.

- The generalized nested logit model used in HISIM2 allows an HIU's health insurance coverage choices to span multiple nests.

For more information about the generalized nested logit model, see Wen and Koppelman (2001) and Train (2009).

Example of the Choice Set for a Multiperson HIU

Consider a three-person HIU in which:

- One person has an offer of employment-based single or family coverage,

- One person (a child) is eligible for CHIP, and

- All three people are lawfully present in the country.

Such an HIU would have 8 groups of alternatives to choose from (or 12 total alternatives, because an HIU that enrolls in nongroup coverage could choose to enroll in a bronze, silver, or gold plan).

Example of the Choice Set for a Multiperson HIU (Continued)

Child enrolls in CHIP, everyone else enrolls in employment-based family coverage

Employment-based coverage   CHIP

Everyone enrolls in employment-based family coverage

Employment-based coverage

Child enrolls in CHIP, everyone else enrolls in nongroup coverage outside the marketplace

Nongroup outside the marketplace   CHIP

Person 1 enrolls in employment-based single coverage, and Persons 2 and 3 are uninsured

Employment-based coverage   Uninsured

Child enrolls in CHIP, everyone else enrolls in nongroup coverage through the marketplace

Nongroup through the marketplace   CHIP

Child enrolls in CHIP, Person 1 enrolls in employment-based single coverage, and Person 2 is uninsured

Employment-based coverage   Uninsured   CHIP

Everyone is uninsured

Uninsured

Child enrolls in CHIP, everyone else is uninsured

Uninsured   CHIP

Utility Specification: Multiperson HIUs

The utility for an HIU i with multiple members $j = 1, ..., J_i$ is similar to utility for a single-person HIU.

$$U_{in} = \beta_2 V_{in} + \varepsilon_{in}$$

$$V_{in} = y_i - C_{in} - E[H_{in}] - \frac{1}{2}\rho_n Var(H_{in}) + \sum_{j=1}^{J_i} \delta_{2n}(y_i, a_j, e_j)$$

The value function is similar to the one for single-person HIUs but includes the sum of the utility shifters for each of the HIU's members.

The predicted values, V_{in}, are normalized by a different scaling factor β_2.

The distribution used for the idiosyncratic unobservable component implies a generalized nested logit model.

The utility shifter for each member of the HIU is based on the type of coverage that he or she receives under the alternative given that member's eligibility, e_j, for different types of coverage.

HIU Utility Parameters

CBO estimates most utility function parameters by fitting the model's equations to the data but sets the value of others on the basis of information from the research and from experts on health insurance markets and this type of model.

The utility shifters (δ_n) and two scaling parameters (β) are estimated.

All remaining parameters are set:

- The coefficient of absolute risk aversion (ρ_n), and

- The dissimilarity and allocation parameters in the generalized nested logit model.

HIU Utility Parameters: δ_n

CBO estimates the utility shifters (δ_n) by finding values that minimize the difference between coverage predictions from the model and coverage targets by type of insurance, age, and income.

The agency combines sample weights for each person with choice probabilities to obtain the predicted aggregate coverage distribution. For example, if the person's sample weight is 100, probability of choosing a silver plan through a marketplace is 75 percent, and probability of choosing to be uninsured is 25 percent, that person would represent 75 people predicted to be enrolled in a silver plan through a marketplace and 25 people predicted to be uninsured.

Coverage targets are CBO's preliminary estimates from individual data sources of the actual number of people with a particular coverage status. For example, one coverage target is the number of people who were enrolled in a silver plan through a marketplace, who were under 30 years old, whose multiperson HIU's income was between 1.38 and 2.50 times the federal poverty level, and who received a premium tax credit.

HIU Utility Parameters: β

The scaling factors, $\boldsymbol{\beta}$, also determine the degree to which HIUs' decisions are predicted by variables within the model and are estimated on the basis of how the model fits the underlying data.

Specifically, they are estimated by minimizing the sum of squared differences between the predicted number of people insured in an HIU and the number of people insured in an HIU reported in the base data.

Sources of Data Used to Calibrate Utility Function Parameters

Coverage	Source
Employment-Based	Medical Expenditure Panel Survey—Insurance Component (MEPS-IC) and Household Component (MEPS-HC), OPM
Nongroup	CMS Medical Loss Ratio data, CMS quarterly effectuated enrollment reports, Healthcare.gov insurance marketplace data, MEPS-HC, Covered California data, New York State of Health Data
None (Uninsured)	MEPS-HC and NHIS
Medicaid and CHIP	Form CMS-64, MSIS, Medicaid Analytic Extract data, Statistics Enrollment Data System (for CHIP)

CHIP = Children's Health Insurance Program; CMS = Centers for Medicare & Medicaid Services; MSIS = Medicaid Statistical Information System; NHIS = National Health Interview Survey; OPM = Office of Personnel Management.

For more details on the data used for calibration, see Jessica Banthin and others, *Sources and Preparation of Data Used in HISIM2—CBO's Health Insurance Simulation Model*, Working Paper 2019-04 (Congressional Budget Office, April 2019), www.cbo.gov/publication/55087.

People Whose Coverage Type Does Not Change Over Time

People with some types of health insurance coverage are projected to be unlikely to change their coverage status in response to the types of policy proposals that HISIM2 is designed to simulate.

For example, people who are under age 65, disabled, and enrolled in Medicare in the base year are generally enrolled in Medicare the following year.

To simplify the analysis, the coverage status of such people mirrors changes in the population over time, and their coverage decision is not allowed to change during the projection period.

Modeling Decisions by Firms

Overview of Firms' Behavior

In this model, firms make decisions about whether to offer employment-based insurance and what type of plan to offer.

Firms are restricted to offer only one type of plan: an HDHP, HMO, or PPO.

Each decision depends on a firm's expected premium contributions, tax liabilities, health reimbursement arrangement (HRA) and health savings account (HSA) contributions, and penalty payments under the alternative; on employees' demand for the alternative; and on an unobserved idiosyncratic factor.

Firms' responses to changes in premiums and policies are roughly calibrated to match values in the research literature.

Firms' Decisions

For the base year of the model, CBO imputes the type of plan, if any, that a firm offers.

- A firm's offer decision is based largely on CPS survey questions and is calibrated to MEPS-IC estimates of offers.

- If a firm offers health insurance, the type of plan is imputed with an estimate of its employees' demand for the plan and MEPS-IC data on the share of firms offering each type of plan.

For subsequent years, firms may change their decisions within the model, although switching a decision from the previous year has a cost.

Firms' Objective Function

The value of firm k's objective function for alternative ℓ is a function of its employees' willingness to pay for it, the net cost of offering it, and a calibrated firm- and plan-specific shifter $\gamma_{k\ell}$. The objective function is measured on a per-employee basis.

$$U_{k\ell} = WTP_{k\ell} - NetCost_{k\ell} + \gamma_{k\ell}(\ell^*)$$

$WTP_{k\ell}$ is the average willingness of a firm's employees to pay for alternative ℓ.

$NetCost_{k\ell}$ is the expected cost of offering alternative ℓ, which is equal to the firm's expected premium contributions, including any contributions to HRAs or HSAs and net of any expected changes in corporate, FICA, and excise tax liabilities or employer-mandate and unaffordable-offer penalties.

$\gamma_{k\ell}$ is a randomly assigned shifter that increases or decreases the value of each alternative for each firm. The distribution of the shifter depends on ℓ^*, the alternative that a firm was assigned to choose in the base year or chose in the previous year.

Two Key Factors Affecting Firms' Decisions

A firm's expected contribution to the premium. Premiums are endogenously constructed within the model by means of individual-level health care spending distributions, plans' characteristics, and load factors.

The employer's share of the premium is imputed with MEPS-IC data about the distribution of employees' premium shares by firm size, the percentage of the firm's workers earning low wages, and the percentile of the firm's premium for single plans.

Employees' demand for their firm to offer insurance. Demand is estimated as the average difference between the employees' expected maximum utility under choice sets with and without their firm's insurance offer.

Load factors account for increases in premiums that are attributable to insurers' profits, to firms' risk-bearing costs and administrative costs, and to active enrollees' cross-subsidization of retirees' plans.

Calibration of the Model's Parameters for Firms' Decisions

The calibration of switching costs and the distribution of firms' unobserved factors accomplishes three goals:

- Calibration is consistent with imputed choices in the base year of the model,

- Firms' responses to changes in premiums and policy are consistent with the research literature, and

- Firms have heterogeneous preferences.

Further Information

To provide more detail about how HISIM2 works, CBO has made available segments of its computer code.

The code has been posted to CBO's website as supplemental material to this document at www.cbo.gov/publication/55097.

Citations

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About This Document

This document was prepared to enhance the transparency of CBO's work and to encourage external review of that work. In keeping with CBO's mandate to provide objective, impartial analysis, the document makes no recommendations.

The development of CBO's health insurance simulation model is an ongoing process that involves sharing information about the model and improving it in response to new data and feedback that CBO receives. Over the past year, CBO has made several presentations on the development of the new model. CBO has also solicited input from many experts—such as those on its technical review panel for the model—with knowledge on a variety of topics, including microsimulation modeling, health insurance markets, federal health programs, and data sources. In addition, CBO has received helpful input from seminar participants at the Urban Institute, the RAND Corporation, the Heritage Foundation, the Agency for Healthcare Research and Quality, and the Office of the Actuary at CMS. CBO has used those experts' feedback to further develop the model. As with all of CBO's models, this one will be regularly updated to incorporate new data and changes in law.

About This Document (Continued)

Jessica Banthin, Keren Hendel, Ben Hopkins, Geena Kim, Sean Lyons, Alexandra Minicozzi, and Eamon Molloy prepared the document with guidance from David Weaver. Chad Chirico, Sarah Masi, the staff of the Joint Committee on Taxation, and members of the Technical Review Panel for CBO's health insurance simulation model provided helpful comments.

Mark Hadley, Jeffrey Kling, and Robert Sunshine reviewed the document. Benjamin Plotinsky edited it and prepared it for publication. An electronic version is available on CBO's website (www.cbo.gov/publication/55097).