

Congressional Budget Office
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How Code Segments Published in April 2019 Are Used in HISIM2—CBO’s Health Insurance Simulation Model

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In April 2019, the Congressional Budget Office published segments of computer code from the new version of its health insurance simulation model, HISIM2, showing how the probabilities of choices among the available coverage options are calculated for health insurance units (HIUs, the decision-making units in the model). This document explains how those code segments are used within the full model.

CBO selected those segments because they illustrate key aspects of the model and are therefore the most valuable for the purpose of making HISIM2 more transparent. They complement other documentation of HISIM2 by showing how variables created in the preparation of data are used in the model, details about the choice sets of consumers, details about the way that information is aggregated within multiperson HIUs, and so on. The amount of code prepared for publication was limited by CBO’s resources and time, as well as by the demands of other priorities.

Overview of the Structure of HISIM2

HISIM2’s code performs four operations:

- Preparation of data,
- Calibration of the model,
- Simulation using the model, and
- Output of statistics.

In the preparation routine, CBO uses the Current Population Survey (CPS) and numerous other data sources to construct an individual-level database that includes key variables needed to model decisions about health insurance. Those variables include demographic and family characteristics, income, employment, the availability of employment-based insurance coverage (ESI), and self-reported health status. After adjusting and supplementing the CPS data in the base year, CBO develops the input data for each year through the end of the 11-year period covered by the agency’s baseline budget projections.¹

In the calibration routine, CBO uses base-year data and estimates values for two types of parameters: the utility shifters, δ , and the scaling factors, β .² The utility shifters increase or

¹ 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.

² For the equations defining those parameters, see Congressional Budget Office, “HISIM2—The Health Insurance Simulation Model Used in Preparing CBO’s Spring 2019 Baseline Budget Projections” (April 2019), www.cbo.gov/publication/55097.

decrease the value of each type of coverage, sometimes for a particular age, income, or both. Those shifters capture such concepts as awareness of insurance alternatives, access to insurance alternatives, attitudes toward insurance, and unmeasured differences in insurance alternatives, such as network size. The scaling factors help translate the value that an HIU places on a coverage alternative into dollars.

In the simulation routine, CBO calculates the utilities of HIUs from choosing various insurance alternatives and the probabilities of HIUs' choices of coverage for each year through the end of the 11-year period.

In the output routine, CBO calculates total enrollment of individuals by coverage type and by individual characteristics such as age. That information is used by other models to estimate the net federal subsidies for health insurance.³

The Simulation Routine in HISIM2

All of the computer code segments published in April 2019 are used in the simulation routine, in which CBO simulates HIUs' choice of coverage. This section briefly explains each of the modules from the simulation code.

- The first module reads in the individual-level data from the preparation routine and translates the data into HIU-level data.
- The second module sets the model's parameters. Some of the parameters are from the calibration and others are set on the basis of the research literature.
- The third module includes four major components:
 - Simulating firms' offers of coverage,
 - Merging that simulated offer information onto HIU-level data and setting up the insurance markets (which uses the code segment *prep_for_simulated_hiu_file.sas*),
 - Simulating HIUs' choices on the basis of their utilities (which uses the other five code segments discussed in this document), and
 - Balancing insurer cost and revenue in the nongroup market on the basis of predicted enrollment to set premiums.

³ Examples of such other models are CBO's Medicaid enrollment model and separate models that analyze aspects of current law that are simplified in HISIM2.

- The fourth module reshapes HIU-level data so that each observation is at the individual level to calculate total enrollment of individuals by coverage type and by individual characteristics such as age.

The Code Segments Published

CBO published six segments of computer code in April 2019:

- 1) *prep_for_simulated_hiu_file.sas*
- 2) *simulate_multi_person_HIUs.sas*
- 3) *simulate_single_person_HIUs.sas*
- 4) *simulate_HIUs_cvrgheld_const.sas*
- 5) *calc_U_ESI_Fpo_hiu2p.sas*
- 6) *calc_U_nongroup_hiu1.sas*

The first segment sets up data for simulations. The second, third, and fourth segments simulate the choices of coverage by three types of decisionmaking units: multiperson HIUs, single-person HIUs, and HIUs in which all members' coverage types are held constant because they are unlikely to change their health insurance coverage status in response to the types of policy proposals that HISIM2 is designed to simulate. The fifth and sixth segments are two examples of how utility is calculated for selected combinations of coverage alternatives.

1) *prep_for_simulated_hiu_file.sas* is used to combine the prepared data and the simulated information about firms' offers and to define necessary variables for calculations involving HIUs' utility and probability, such as public insurance eligibility, premium subsidy in the marketplaces, and cost-sharing reduction payments.

2) *simulate_multi_person_HIUs.sas* is used to calculate the utilities and probabilities of choices among the available coverage options for multiperson HIUs.⁴ For such HIUs, HISIM2 models 36 alternatives representing combinations of coverage types in which HIUs may enroll their members, as shown in Table 1. The number of modeled alternatives was chosen to balance realism and tractability. CBO uses a generalized nested logit model to describe the decision of multiperson HIUs among available alternatives because the people within the same HIU can have coverage types that can be allocated to multiple nests. An allocation parameter, α_{nm} , captures the degree to which alternative n is associated with nest m . CBO sets the allocation parameters to values on the basis of the fraction of people eligible to take up each coverage type (belonging to a certain nest) within an alternative. Under each alternative, members of the HIU are sorted into different types of coverage on the basis of their eligibility. For example, a three-

⁴ Depending on the number of members, HIUs face significantly different choice sets, and thus multiperson and single-person HIUs are modeled separately in HISIM2. A multiperson 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.

person HIU would have a choice set with 12 alternatives if Person 1 has an offer of employment-based single or family coverage, Person 3 is eligible for the Children’s Health Insurance Program (CHIP), and all three people are lawfully present in the country. (See Table 1; those alternatives would be 1, 3, 7, 18, and 29–36.)

3) *simulate_single_person_HIUs.sas* is used to calculate the utilities and probabilities of choices among the available coverage options for single-person HIUs.⁵ For such HIUs, HISIM2 models 10 alternatives, as shown in Table 2. CBO uses a nested logit model to describe the decision of single-person HIUs among available alternatives. For example, a single person without an employment-based offer and not eligible for Medicare or Medicaid would have a choice set with 7 alternatives. (See Table 2; those alternatives would be 1 and 5–10.) HISIM2’s code works through multiperson HIUs before single-person HIUs to first calculate the probability that people ages 19–26 are covered by their parents’ insurance in a multiperson HIU. (Those people are called “nondependent children” in the computer code.) Then the code for single-person HIUs is used to estimate the remaining coverage probabilities for those nondependent children and other single people.

For both multiperson and single-person HIUs, coverage choices are grouped into five nests: enrolling in employment-based coverage, enrolling in nongroup coverage in the marketplaces, enrolling in nongroup coverage outside the marketplaces, enrolling in public coverage, and being uninsured. Some nests include several coverage types, such as bronze, silver, or gold coverage in the marketplaces.⁶

4) *simulate_HIUs_cvrg_held_const.sas* is used to count the number of people in HIUs in which all members’ coverage types are held constant because those people are all unlikely to change their health insurance coverage status in response to the types of policy proposals that HISIM2 is designed to simulate. Those people include the following:

- Medicare enrollees without an employment-based insurance offer,
- Dual enrollees in Medicaid and Medicare,
- Medicare enrollees under age 65,
- Foster children with Medicaid,

⁵ A single person is his or her own HIU.

⁶ Alternatives within the same nest are considered closer substitutes than alternatives in different nests. See Congressional Budget Office, “HISIM2—The Health Insurance Simulation Model Used in Preparing CBO’s Spring 2019 Baseline Budget Projections” (April 2019), www.cbo.gov/publication/55097.

- People who are eligible for Medicaid because of a disability,
- People covered by military or veterans' health programs,
- People with alternative sources of coverage (including student health plans, the Indian Health Service, and foreign sources),
- Policyholders or dependents with employment-based coverage under COBRA (the Consolidated Omnibus Budget Reconciliation Act),
- Adults with both Medicaid and employment-based coverage, and
- Dependents of a policyholder with employment-based coverage who live outside the policyholder's home.

5) *calc_U_ESI_Fpo_hiu2p.sas* is used to calculate a multiperson HIU's utilities from choosing two alternative coverage combinations of public insurance and ESI when the choice is which adult's ESI family offer to take up. (See Table 1; those alternatives would be 3 and 4.)

6) *calc_U_nongroup_hiu1.sas* is used to calculate a single-person HIU's utilities from choosing nongroup coverage alternatives. (See Table 2; those alternatives would be 5–10.)

Table 1. Potential Alternatives in Choice Sets for Multiperson HIUs

Nests Each Alternative Belongs to	Nests		Uninsured (a)	Public Insurance (a)			ESI					Nongroup in the Marketplaces			Nongroup outside the Marketplaces		
	Coverage Types	Alternatives		Medicare (b)	Medicaid	CHIP	Family Plan (c)		Single Plan			Bronze	Silver	Gold	Bronze	Silver	Gold
							1st offer	2nd offer	1st offer	2nd offer	3rd offer						
ESI (Family)	1						x										
	2							x									
ESI (Family) and Public Insurance	3			x	x		x										
	4			x	x			x									
	5			x (d)			x										
	6			x (d)				x									
ESI (Single), Public Insurance and Uninsured	7	x	x	x	x				x								1
	8	x	x	x	x				x								2
	9	x	x	x	x					x							2
	10	x	x	x	x				x	x							2
	11	x	x	x	x				x								3
	12	x	x	x	x					x							3
	13	x	x	x	x						x						3
	14	x	x	x	x				x	x							3
	15	x	x	x	x				x		x						3
	16	x	x	x	x					x	x						3
ESI (Single) and Uninsured	17	x	x	x	x				x	x	x						3
	18	x							x								1
	19	x							x								2
	20	x								x							2
	21	x							x	x							2
	22	x							x								3
	23	x								x							3
	24	x									x						3
	25	x							x	x							3
	26	x							x		x						3
Nongroup in the Marketplaces, Public Insurance and Uninsured	27	x							x	x	x						3
	28	x							x	x	x						3
	29	x	x	x	x							x					
Nongroup outside the Marketplaces, Public Insurance and Uninsured	30	x	x	x	x								x				
	31	x	x	x	x									x			
	32	x	x	x	x										x		
Public Insurance and Uninsured	33	x	x	x	x											x	
	34	x	x	x	x												x
	35	x	x	x	x												
Uninsured	36	x															

Notes: (a) In the nests of uninsured and public insurance, x denotes that HIU members are eligible for the coverage options.

(b) Medicare is a potential coverage option in a choice set when an HIU member is eligible for Medicare, is age 65 or over, and has access to an employment-based insurance offer. (c) If both heads of an HIU have ESI family plan offers, only one of the first or second offer (ordered by the age of policyholders) is taken up; if only one head has a family plan offer, that offer (that is, the first offer) is taken up. (d) Children are covered by both employment-based coverage and Medicaid.

Table 2. Potential Alternatives in Choice Sets for Single-Person HIUs

Coverage Types Alternatives	Nests	Uninsured (a)	Public Insurance (a)		ESI	Nongroup in the Marketplaces			Nongroup outside the Marketplaces		
			Medicare (b)	Medicaid	ESI Single	Bronze	Silver	Gold	Bronze	Silver	Gold
1		x									
2			x								
3				x							
4					x						
5						x					
6							x				
7								x			
8									x		
9										x	
10											x

Notes: (a) In the nests of uninsured and public insurance, x denotes that HIU members are eligible for the coverage options.

(b) Medicare is a potential coverage option in a choice set when an HIU member is eligible for Medicare, is age 65 or over, and has an employment-based insurance offer.