# A Unified Approach for Ex Ante Policy Evaluation

Supplemental Materials

John Graves, Vanderbilt University

## 1 Discrete Choice Model

This section describes the structure, assumptions and calibration of a discrete time and choice model of U.S. health insurance coverage.

To begin, consider a model of insurance choice among $J$ alternatives (including the choice not to insure). Define $U_{itj}$ as the utility for choice unit $i$ from selecting choice $j$ at time $t$.

$$U_{itj} = V(\mathbf{x_{itj}}, \mathbf{z_i}) + \epsilon_{ij}$$

where $\mathbf{x_{itj}}$ is a vector of time-varying attributes of the $J$ choices and the health insurance unit (HIU), or the collection of related family members who could enroll under the same plan. Utility also depends on fixed attributes of the HIU ($\mathbf{z_i}$), and an unobservable component $\epsilon_{itj}$.

For HIU $i$, the choice of insurance $y_{it}$ is based on maximizing utility across the $J$ alternatives at time $t$:

$$y_{it} = \arg\max_j [U_{itj}, j = 1, \ldots, J]$$

We next define a function $B(\cdot)$ mapping utility from choice $j$ to $r_{ij} = P(y_{it} = j)$, the probability of individual $i$ selecting choice $j$. If the error terms $\epsilon_{ij}$ are independent across units and are distributed Type I Extreme Value, we get a standard conditional logit for $B(\cdot)$. However, other link functions—such as based on a nested logit or multinomial logit model—could also be used.

# 2 From Utility to Probability: Linkages to Common Microsimulation Approaches

The specification of choice probabilities via a link function to an underlying utility maximization model is the theoretical chassis for most major microsimulation models of the U.S. health care system. This includes models used by the Congressional Budget Office (CB), the RAND Corporation, and the Urban Institute, among others.

For example, the CBO model utilizes a similar underlying utility equation:

$$U_{ij} = \beta_1 V_{ij} + \epsilon_{ij}$$

where the paramter $\beta$ rescales utility into dollar terms. In the CBO model, the systematic component of utility (i.e., $V_{ij}$) is modeled using microdata on individuals and simulated employer choices to offer insurance.

$$V_{ij} = \underset{\text{Income}}{y_i} - \underset{\substack{\text{Cost of}\\ \text{plan choice}\\ \text{(premium,}\\ \text{mandate penalty,}\\ \text{etc.)}}}{C_{ij}} - \overset{\text{OOP Costs}}{E[H_{ij}]} - \frac{1}{2}\underset{\substack{\text{Coef. abs}\\ \text{risk aversion}}}{\rho_j}\overset{\text{OOP Costs}}{\mathtt{Var}(H_{ij})} + \overbrace{\delta_{1j}(\underset{\text{Income}}{y_i}, \underset{\text{Age}}{a_i})}^{\text{Utility Adjuster}}$$

The CBO model similarly defines a link function $B(\cdot)$ converting utility to choice probabilities based a on nested logit in which individuals first select the *type* of insurance they will have (e.g., employer, non-group, public, or uninsured) and then conditional on that choice, select among plans within that type.

In addition to sharing a common "DNA" with major microsimulation models, another nice feature of the discrete choice model structure outlined above is that it also maps directly into a reduced form modeling structure. Under this structure, changes in choice probabilities are modeled using microdata on individuals by applying reduced form literature-based elasticity estimates to simulated changes in price. This "reduced-form" or "elasticity-based" approach to microsimulation of U.S. health reform was previously used by the CBO (prior to 2019) and in other major microsimulation models.

# 3 Insurance Choice as a Markov Process

As discussed in the introduction to this study, a major downside to common approaches to microsimulation is that they require considerable h

To address this shortcoming, we next take the utility maximization model developed above and map it into a "sufficient statistics" approach to modeling changes to U.S. health insurance policy. In so doing we can summarize policy changes in terms of a minimal set of parameters.

To do so we first recognize that the insurance choice process at two time periods can be summarized in terms of a Markov trace. First, define the *ex ante occupancy vector* $\tilde{\mathbf{p}}$ summarizing the count or fraction of the population at baseline.

- Also define a transition probability matrix $\mathbf{R_i} = [r_{irs}]$.
  - Cells in this $J \times J$ matrix defined by transition probabilities: $r_{irs} = P(y_{it} = s|y_{i,t-1} = r)$
  - At a population level (with size $N$) define $\mathbf{R} = [r_{rs}]$ where $r_{rs} = \sum_{i=1}^{N} r_{irs}/N$.
- $\mathbf{p}$, the distribution of coverage at time $t$, is given by $\tilde{\mathbf{p}}'\mathbf{R}$.

# 4 Development and Calibration of Policy Simulation Model

The basis for the simulation model is longitudianl data on insurance choice from the 2014 Survey of Income and Program Participation (SIPP) calibrated to American Community Survey (ACS) on insurance coverage from 2015 to 2018.

| | Ex Ante Share | | Transition Probability (Nonexpansion States) | | | |
|---|---|---|---|---|---|---|
| | Expansion | Nonexpansion | Employer - Own Policy | Private - Non-Employer | Public | Uninsured |
| Employer - Own Policy | 0.579 | 0.554 | 0.9007 | 0.0278 | 0.0275 | 0.0441 |
| NA | | | (p=0.92) | (p=0.18) | (p=0.96) | (p< 0.01) |
| Private - Non-Employer | 0.047 | 0.051 | 0.2450 | 0.6216 | 0.0384 | 0.0951 |
| NA | | | (p=0.24) | (p=0.75) | (p=0.88) | (p=0.01) |
| Public | 0.156 | 0.134 | 0.0712 | 0.0062 | 0.8514 | 0.0712 |
| NA | | | (p=0.22) | (p=0.94) | (p=0.64) | (p=0.39) |
| Uninsured | 0.219 | 0.261 | 0.1567 | 0.0640 | 0.1173 | 0.6620 |
| NA | | | (p=0.92) | (p=0.07) | (p=1.00) | (p< 0.01) |

Graves, McWilliams and Hatfield (2019)

| | Ex Ante Share | | Change in Transition Probability | | | |
|---|---|---|---|---|---|---|
| | Expansion | Nonexpansion | Employer - Own Policy | Private - Non-Employer | Public | Uninsured |
| Employer - Own Policy | 0.579 | 0.554 | 0.0081 | -0.0037 | 0.0068 | -0.0112 |
| | | | (p= 0.17) | (p= 0.35) | (p= 0.11) | (p= 0.01) |
| Private - Non-Employer | 0.047 | 0.051 | -0.0169 | 0.0301 | 0.0318 | -0.0449 |
| | | | (p= 0.45) | (p= 0.47) | (p= 0.24) | (p= 0.02) |
| Public | 0.156 | 0.134 | -0.0072 | 0.0051 | 0.0071 | -0.0050 |
| | | | (p= 0.47) | (p= 0.14) | (p= 0.75) | (p= 0.78) |
| Uninsured | 0.219 | 0.261 | 0.0210 | -0.0221 | 0.1071 | -0.1060 |
| | | | (p= 0.16) | (p= 0.10) | (p< 0.01) | (p< 0.01) |

Graves, McWilliams and Hatfield (2019)

```
## # A tibble: 8 x 6
## # Groups:   non_expansion_state [2]
##   non_expansion_state coverage_type `2015` `2016` `2017` `2018`
##                 <int> <chr>          <dbl>  <dbl>  <dbl>  <dbl>
## 1                   0 01_esi_own    0.633  0.638  0.644  0.650
## 2                   0 02_priv_oth   0.0854 0.0856 0.0809 0.0772
## 3                   0 03_public     0.180  0.186  0.185  0.182
## 4                   0 04_uninsured  0.102  0.0896 0.0895 0.0909
## 5                   1 01_esi_own    0.608  0.615  0.620  0.623
## 6                   1 02_priv_oth   0.102  0.103  0.0936 0.0894
## 7                   1 03_public     0.110  0.112  0.111  0.110
## 8                   1 04_uninsured  0.180  0.170  0.175  0.177
```

```
## Warning in min(rows_matched): no non-missing arguments to min; returning Inf
```

```
## Warning in max(rows_matched): no non-missing arguments to max; returning -Inf
```

| | Employer-Sponsored | | Non-Group | | Public | | Uninsured | |
|---|---|---|---|---|---|---|---|---|
| | Calibrated | Target | Calibrated | Target | Calibrated | Target | Calibrated | Target |
| **Nonexpansion** | | | | | | | | |
| 2015 | 0.638 | 0.633 | 0.084 | 0.085 | 0.183 | 0.180 | 0.096 | 0.102 |
| 2016 | 0.642 | 0.638 | 0.082 | 0.086 | 0.184 | 0.186 | 0.093 | 0.090 |
| 2017 | 0.644 | 0.644 | 0.081 | 0.081 | 0.184 | 0.185 | 0.091 | 0.089 |
| 2018 | 0.646 | 0.650 | 0.080 | 0.077 | 0.184 | 0.182 | 0.090 | 0.091 |
| **Expansion** | | | | | | | | |
| 2015 | 0.613 | 0.608 | 0.099 | 0.102 | 0.111 | 0.110 | 0.177 | 0.180 |
| 2016 | 0.616 | 0.615 | 0.097 | 0.103 | 0.111 | 0.112 | 0.176 | 0.170 |
| 2017 | 0.619 | 0.620 | 0.095 | 0.094 | 0.111 | 0.111 | 0.175 | 0.175 |
| 2018 | 0.621 | 0.623 | 0.094 | 0.089 | 0.111 | 0.110 | 0.174 | 0.177 |

```
## Warning: `cols` is now required.
## Please use `cols = c(p)`

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## Warning in min(rows_matched): no non-missing arguments to min; returning Inf

## Warning in max(rows_matched): no non-missing arguments to max; returning -Inf
```

| Model Parameters | | | | | | | |
|---|---|---|---|---|---|---|---|
| Parameter | Short Name | Value | PSA Distribution | Mean | Standard Deviation | Maximum | Minimum |
| Price-Fixed Subsidy Parameters | | | | | | | |
| Moral hazard effect of insurance | phi | 0.250 | Normal | 0.25 | 0.05 | | |
| Social welfare weight | eta | 0.750 | Uniform | | | 1 | 0.5 |
| Subsidized monthly premium | plan_premium | 25.000 | | | | | |
| Fraction of uninsured population eligible for subsidies | frac_uninsured_elig | 0.700 | Normal | 0.7 | 0.05 | | |
| Medicaid Parameters | | | | | | | |
| Medicaid spending among control compliers | G_Cx | 2.721 | Normal | 2721 | 20 | | |
| Average cost to the government per Medicaid recipient | G | 3.600 | Normal | 3600 | 20 | | |
| OOP spending among control compliers | OOP_Cx | 569.000 | Normal | 569 | 50 | | |
| OOP spending among treatment compliers | OOP_Tx | 0.000 | Normal | 0 | 0 | | |
| Pure insurance value of Medicaid | I | 760.000 | Normal | 760 | 200 | | |
| Shared Parameters | | | | | | | |
| Government incidence of uncompensated care | gov_incidence | 0.500 | Uniform | | | 1 | 0 |
| Welfare weight for targeted income group | v_i | 0.650 | Normal | 0.65 | 0.02 | | |
| Welfare weight for high-income group | v_j | 1.100 | Normal | 1.15 | 0.02 | | |
| FPL of recipients | pop_fpl | 150.000 | | | | | |
| Out-of-pocket share of expenditures among uninsured | uninsured_oop_share | 0.209 | Normal | 0.2 | 0.1 | | |

| Model Parameters Shared Across Strategies | | | | | | | |
|---|---|---|---|---|---|---|---|
| Parameter | Short Name | Value | PSA Distribution | Mean | Standard Deviation | Maximum | Minimum |
| Government incidence of uncompensated care | gov_incidence | 0.500 | Uniform | | | 1 | 0 |
| Welfare weight for targeted income group | v_i | 0.650 | Normal | 0.65 | 0.02 | | |
| Welfare weight for high-income group | v_j | 1.100 | Normal | 1.15 | 0.02 | | |
| FPL of recipients | pop_fpl | 150.000 | | | | | |
| Out-of-pocket share of expenditures among uninsured | uninsured_oop_share | 0.209 | Normal | 0.2 | 0.1 | | |

| Model Parameters: Medicaid Expansion | | | | | | | |
|---|---|---|---|---|---|---|---|
| Parameter | Short Name | Value | PSA Distribution | Mean | Standard Deviation | Maximum | Minimum |
| Medicaid spending among control compliers | G_Cx | 2.721 | Normal | 2721 | 20 | | |
| Average cost to the government per Medicaid recipient | G | 3.600 | Normal | 3600 | 20 | | |
| OOP spending among control compliers | OOP_Cx | 569.000 | Normal | 569 | 50 | | |
| OOP spending among treatment compliers | OOP_Tx | 0.000 | Normal | 0 | 0 | | |
| Pure insurance value of Medicaid | I | 760.000 | Normal | 760 | 200 | | |

```
## Warning in bind_rows_(x, .id): binding character and factor vector, coercing
## into character vector
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## into character vector
```

| Model Parameters: Price-Linked Subsidy | | | | | | | |
|---|---|---|---|---|---|---|---|
| Parameter | Short Name | Value | PSA Distribution | Mean | Standard Deviation | Maximum | Minimum |
| Moral hazard effect of insurance | phi | 0.25 | Normal | 0.25 | 0.05 | | |
| Social welfare weight | eta | 0.75 | Uniform | | | 1 | 0.5 |
| Subsidized monthly premium | plan_premium | 25.00 | | | | | |
| Fraction of uninsured population eligible for subsidies | frac_uninsured_elig | 0.70 | Normal | 0.7 | 0.05 | | |
| Coverage Takeup: Regression-Discontinuity Estimates | beta | | Multivariate Normal | | | | |

```
## Warning: Expected 4 pieces. Missing pieces filled with `NA` in 8 rows [3, 4, 7,
## 8, 11, 12, 13, 14].

## Warning in min(rows_matched): no non-missing arguments to min; returning Inf

## Warning in max(rows_matched): no non-missing arguments to max; returning -Inf
```

| | Baseline | Expand In-Kind Benefits (Medicaid) | Price-Linked Subsidy |
|---|---|---|---|
| Coverage Effects | | | |
| Employer-Sponsored Insurance | 0.641 | 0.006 | 0.0000000 |
| Private Non-Group | 0.087 | –0.003 | 0.0481395 |
| Public | 0.133 | 0.027 | 0.0000000 |
| Uninsured | 0.139 | –0.030 | -0.0481395 |
| Marginal Value of Public Funds | | 0.804 | 0.8927658 |