Measuring Ex-Ante Welfare in Insurance Markets

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Revealed Preference in Insurance Markets

- How should we measure the welfare impacts of subsidies and mandates in insurance markets?

- Revealed preference theory is often used as a foundation for welfare analysis of many government policies.

- Recent applications use exogenous price variation in insurance markets to measure WTP and the cost of insurance (Einav, Finkelstein, and Cullen (2010); Hackmann, Kolstad, and Kowalski (2015); Finkelstein, Hendren, and Shepard (2017); ...)

- Comparing WTP to cost provides a measure of DWL/market surplus of subsidies and mandates
  - If cost exceeds WTP, subsidies impose DWL
Information evolves over time, and people may have knowledge about risk when measuring demand

- LTC, Disability, Life insurance (Hendren, 2013)
- Dental Insurance (Cabral, 2017)
- Unemployment insurance (Hendren, 2016)

Well-known that this can generate adverse selection, but less appreciated that textbook notions of market surplus do not measure canonical notions of expected utility

Depends on when choices happen to be measured (Hirshleifer, 1971)
Motivating Example

- Individuals have $30

- Risk of losing $m$, uniformly distributed between 0 and 10

- Willing to pay $0.50$ markup for full insurance if CRRA is 3
  - Indifferent between roughly $24.50$ versus uniformly distributed consumption on $[20,30]$

- Suppose we observe exogenous price variation for insurance
  - What would be the WTP and cost curves?
Ex-Ante Willingness to Pay and Cost
Ex-Ante Willingness to Pay and Cost

\[ S^{CE} = 1 \]
Ex-Ante Willingness to Pay and Cost

\[ W^{\text{Ex-Ante}} = \$0.50 \]

\[ s^{CE} = 1 \]
Motivating Example

- What if people have information about their risk when we measure demand?

- Begin with extreme case: suppose individuals learn their loss
  - Willingness to pay (“demand”) equals cost, $D(s) = m(s)$
Observed Willingness to Pay and Cost

Fraction Insured (s)

- WTP
- Cost
Observed Willingness to Pay and Cost

\[ s^{CE} = 0 \]

Fraction Insured (s)

- **WTP**
- **Cost**
- **Average Cost**
What are the welfare implications of this unraveling?
Observed Willingness to Pay and Cost

\[ s^{CE} = 0 \]

No lost surplus from foregone trades
Timeline of Information Revelation and Insurance Purchase

Ex-Ante:
$E[u(c)]$

or
$E[u(c)|X]$

Event Realized, $u(c)$
Timeline of Information Revelation and Insurance Purchase

Ex-Ante: 
\[ E[u(c)] \]

or
\[ E[u(c)|X] \]

Knowledge

Event Realized, \( u(c) \)

If choices are made prior to info revelation, revealed preference measures ex-ante utility, \( E[u(c)] \)
Timeline of Information Revelation and Insurance Purchase

Ex-Ante:

\[ E[u(c)] \]

or

\[ E[u(c)|X] \]

Ex-Ante Expected Utility / WTP

Knowledge

Event Realized, \( u(c) \)

Choice

Observed WTP
Timeline of Information Revelation and Insurance Purchase

Ex-Ante: $E[u(c)]$ or $E[u(c)|X]$

Event Realized, $u(c)$

Revealed preference measures WTP for insurance against **remaining risk**, not $E[u(c)]$

Expected Utility / WTP

Knowledge

Choice
Timeline of Information Revelation and Insurance Purchase

Ex-Ante: $E[u(c)]$ or $E[u(c)|X]$

Knowledge

Event Realized, $u(c)$

Choice

Does not capture value of insurance against risk known at time of making choice

$\text{Ex-Ante Expected Utility / WTP} > \text{Avg}\left[\frac{\text{Observed WTP}}{}\right]$
Market Surplus/DWL Depends on When WTP is Measured

Ex-Ante: 
\[ E[u(c)] \]
or
\[ E[u(c)|X] \]

\[ WTP_{\text{Ex-Ante}} \geq E[WTP_1] \geq E[WTP_2] \geq E[WTP_3] = \text{Cost} \]
Goal of Paper: Recover Expected Utility

- Ex-Ante: $E[u(c)]$ or $E[u(c)|X]$
- Observed WTP
- Knowledge
- Event Realized, $u(c)$

Ex-Ante Expected Utility / WTP

Goal of Paper

Choice

Observed WTP
Goal of Paper: Recover Expected Utility

Ex-Ante: $E[u(c)]$ or $E[u(c)|X]$

Knowledge

Goal of Paper

Evaluate policies in this market

Choice

Ex-Ante Expected Utility / WTP

Observed WTP

Event Realized, $u(c)$
Goal of Paper: Recover Expected Utility

Ex-Ante: $E[u(c)]$ or $E[u(c)|X]$

<table>
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<tr>
<th>Ex-Ante Expected Utility / WTP</th>
<th>Event Realized, $u(c)$</th>
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<td>Evaluate policies in this market</td>
<td>From an earlier welfare perspective</td>
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Traditional Approach

Ex-Ante: $E[u(c)]$ or $E[u(c)|X]$

Knowledge

Event Realized, $u(c)$

Ex-Ante Expected Utility / WTP

Observed WTP

Choice
Traditional Approach

Ex-Ante: $E[u(c)]$ or $E[u(c)|X]$

1. Specify $u(c)$ structure

Knowledge

Event Realized, $u(c)$

Choice

Ex-Ante Expected Utility / WTP

Observed WTP
Traditional Approach

Ex-Ante: 
\[ E[u(c)] \]

or 
\[ E[u(c)|X] \]

1. Specify \( u(c) \) structure

Knowledge

Event Realized, \( u(c) \)

2. Specify choice environment

Choice

Observed

WTP

Ex-Ante

Expected Utility / WTP
Traditional Approach

Ex-Ante: $E[u(c)]$ or $E[u(c)|X]$

1. Specify $u(c)$ structure
2. Specify choice environment
3. Specify information set when making choices

Knowledge

Event Realized, $u(c)$

Ex-Ante Expected Utility / WTP

Choice

Observed WTP
Traditional Approach

Ex-Ante: 

\[ E[u(c)] \]

or 

\[ E[u(c)|X] \]

1. Specify \( u(c) \) structure

2. Specify choice environment

3. Specify information set when making choices

4. Estimate model using observed allocations

Event Realized, \( u(c) \)

Observed WTP

Knowledge

Ex-Ante Expected Utility / WTP
My Alternative Approach: Reduced Form + Suff. Stats

Ex-Ante: $E[u(c)]$ or $E[u(c)|X]$

Knowledge

Event Realized, $u(c)$

Ex-Ante
Expected
Utility / WTP

Choice

Observed
WTP
My Alternative Approach: Reduced Form + Suff. Stats

Ex-Ante: 
\[E[u(c)]\] 
or 
\[E[u(c)|X]\]

Knowledge

Event Realized, \(u(c)\)

Choice

Use reduced-form WTP and Cost to value remaining risk

Ex-Ante 
Expected Utility / WTP

Observed WTP
My Alternative Approach: Reduced Form + Suff. Stats

Ex-Ante: $E[u(c)]$ or $E[u(c)|X]$

Ex-Ante Expected Utility / WTP

Knowledge

Provided Sufficient Stats to Value Ex-ante Risk

Use reduced-form WTP and Cost to value remaining risk

Event Realized, $u(c)$

Observed WTP

Choice
My Alternative Approach: Reduced Form + Suff. Stats

Ex-Ante: $E[u(c)]$ or $E[u(c)|X]$

Expected
Utility / WTP

Result 1: Difference in marginal utilities between insured and uninsured

Use reduced-form WTP and Cost to value remaining risk

Event Realized, $u(c)$

Knowledge

Choice

Observed
WTP
My Alternative Approach: Reduced Form + Suff. Stats

Ex-Ante:
\[ E[u(c)] \]
or
\[ E[u(c)|X] \]

Event Realized, \( u(c) \)

Result 2: Benchmark Implementation using:
1. WTP + Cost Curves
2. Risk Aversion

Use reduced-form WTP and Cost to value remaining risk

Expected
Utility / WTP
Remainder of Talk

- Characterize “Ex-Ante” WTP in Simple Example

- Extend to General Case and Apply to Low-Income Health Insurance Subsidies in Massachusetts
Measuring Ex-Ante Willingness to Pay

- Return to example in which \( D(s) = m(s) \)

- Suppose \( s = 50\% \) of the population has insurance

- Obtained by setting prices subject to a resource constraint:
  - Price of insurance, \( p_I \)
  - Price/penalty of being uninsured, \( p_U \)
  - Set so that \( sp_I + (1 - s)p_U = sAC(s) \)

- Paper: Consider non-budget neutral policies
  - Impact on MVPF in Hendren (2016)
From Observed WTP to Ex-Ante WTP

\[ p_I - p_U = $5 \]
From Observed WTP to Ex-Ante WTP

Marginal person WTP $5 for insurance, equal to their cost (i.e. no surplus)
From Observed WTP to Ex-Ante WTP

Ex-ante, how much are you willing to pay to have 50+ds% not 50% insured?
From Observed WTP to Ex-Ante WTP

Marginal Price (WTP) vs. Fraction Insured (s)

Lowers $p_I - p_U$ by $D'(s)ds$

- $ds$
- $WTP$
- Cost
From Observed WTP to Ex-Ante WTP

Marginal Price

Fraction Insured (s)

1 − s pay higher prices

\[ dp_U = -sD'(s)ds \]
From Observed WTP to Ex-Ante WTP

\[ dp_1 = (1 - s)D'(s)ds \]
\[ dp_U = -sD'(s)ds \]
From Observed WTP to Ex-Ante WTP

\[ dp_I = (1 - s)D'(s)ds \]

\[ dp_U = -sD'(s)ds \]

\[ dW = -s(1 - s)D'(s)dsE[u_c|Insured] \]

\[ dW = (1 - s)sD'(s)dsE[u_c|Unins] \]
Result #1: General Formula for Ex-Ante WTP for Insurance

\[ EA(s) = ((1-s)s(-D'(s))) \frac{E[u_c|Insured] - E[u_c|Unins]}{E[u_c]} \]

Size of Transfer

Marginal Utility Difference

\[ s \text{ pay lower prices} \]
\[ dp_I = (1-s)D'(s)ds \]

\[ 1-s \text{ pay higher prices} \]
\[ dp_U = -sD'(s)ds \]

\[ dW = -s(1-s)D'(s)dsE[u_c|Insured] \]
\[ dW = (1-s)sD'(s)dsE[u_c|Unins] \]
Implementing Ex-Ante WTP: Consumption Difference

$EA(s) = ((1 - s) s (-D'(s))) \frac{u_{cc}}{u_c} [E[c|\text{Insured}] - E[c|\text{Unins}]]$

- **Size of Transfer**
- **Marginal Utility Difference**

**Key Assumption:** State independence
Implementing Ex-Ante WTP: Consumption Difference

\[ EA(s) = \left(1 - s\right) s \left(-D'(s)\right) \frac{u_{cc}}{u_c} \left[ E[c|\text{Insured}] - E[c|\text{Uninsured}] \right] \]

- Size of Transfer
- Marginal Utility Difference

Consumption of the insured is $2.5 higher than avg. uninsured.
Result #2: Implement with WTP Curve + Risk Aversion

\[ EA(s) = \frac{\sum_{s} D(s) - E[D(s')] | s' > s]}{\sum_{s} D'(s)(s)} \]

Consumption of the insured is $2.5 lower than avg. uninsured
Result #2: Implement with WTP Curve + Risk Aversion

\[ EA(s) = \frac{u_{cc}}{u_c} [D(s) - E[D(s')|s' > s]] \]

- **Size of Transfer**
- **Marginal Utility Difference**

\[ \frac{E[u_c|Ins] - E[u_c|Unins]}{E[u_c]} \approx 2.5\gamma_{CARA} \]

![Graph showing the relationship between fraction insured and marginal price, with the WTP and cost curves depicted.](image-url)
Result #2: Implement with WTP Curve + Risk Aversion

\[ EA(s) = ((1 - s)s(-D'(s))) \frac{-u_{cc}}{u_c} [D(s) - E[D(s')|s' > s]] \]

Size of Transfer
Marginal Utility Difference

Marginal Price Difference

\[ EA(0.5) = (0.5)(0.5)(10) \left( -\frac{3}{25} \right)(-2.5) \]
\[ = 0.75 \]
Result #2: Implement with WTP Curve + Risk Aversion

\[ EA(s) = ((1-s)s(-D'(s))) \frac{-u_{cc}}{u_c} [D(s) - E[D(s')|s' > s]] \]

Size of Transfer
Marginal Utility Difference

WTP $0.75 for larger insurance mkt prior to learning s

Marginal Price

Fraction Insured (s)

[Graph showing the WTP and cost curves with the WTP $0.75 for larger insurance market prior to learning s marked on the graph.]
Recovering Ex-Ante WTP

Marginal Price

Fraction Insured (s)

- **WTP**
- **Cost**
- 'Ex-ante' WTP, $D(s) + EA(s)$
Recovering Ex-Ante WTP

\[ EA(0.3) = \$0.88 \]

![Graph showing the relationship between Marginal Price and Fraction Insured (s)]

- **WTP**
- **Cost**
- 'Ex-ante' WTP, \( D(s) + EA(s) \)
Recovering Ex-Ante WTP

\[ EA(0.7) = \$0.38 \]

Marginal Price vs. Fraction Insured (s)

- **WTP**
- **Ex-ante** WTP, \( D(s) + EA(s) \)
- **Cost**

Graph showing the relationship between marginal price and fraction insured with specific points marked for 0.7 fraction insured.
Recovering Ex-Ante WTP

\[ \int_0^1 EA(s)ds = \$0.50 \]

Graph showing the relationship between marginal price and fraction insured, with the area under the curve representing the ex-ante WTP, \( D(s) + EA(s) \), and the cost indicated by a dashed line.
Average Ex-Ante WTP is $5.50

\[
\int_{0}^{1} EA(s) ds = 0.50
\]
Remainder of Talk

- Characterize “Ex-Ante” WTP in Simple Example

- Extend to General Case and Apply to Low-Income Health Insurance Subsidies
Low-Income Health Insurance Subsidies

- Finkelstein, Hendren, and Shepard study subsidized exchange in Massachusetts (pre-ACA)
  - Model for ACA: Similar design, low-income population choosing b/n heavily subsidized coverage vs. uninsurance
- Key feature: Subsidies vary by discrete income bin
  - Creates RD variation in premiums owed by enrollees
  - E.g., 149% poverty person has $0 plan; 151% poverty pays $39/month
- Use price variation to estimate WTP, cost of insurance
Subsidy and Premium Discontinuities (2011)

Income, % of Poverty

$ per month

Public Subsidies

Insurer Price

Enrollee Premium

“Affordable Amt.” (cheapest plan) $116

$0

$39

$77

$116
Share of Eligible Population Insured

- 94% at 135% of FPL
- 76% at 200% of FPL
- 70% at 250% of FPL
- 58% at 300% of FPL

RD = -0.24 (0.07) for 94% share
RD = -0.20 (0.05) for 76% share
RD = -0.14 (0.04) for 58% share

%Δ = -26% for 94% share
%Δ = -27% for 76% share
%Δ = -24% for 58% share

P_{min} = $0, $39, $77, $116
Average Insurer Costs, by Income (2009-2013)

RD = 47.3 (7.7)
%Δ = +15%

RD = 32.4 (8.7)
%Δ = +9%

RD = 6.2 (11.9)
%Δ = +2%
WTP and Cost in Finkelstein, Hendren, and Shepard (2017)

![Graph showing the relationship between cost and fraction insured]

- $C(s)$: Cost as a function of the fraction insured ($s$).
- $D(s)$: WTP as a function of the fraction insured ($s$).
Market Surplus Maximizing Allocation

$p_{ms} = $1581

$s_{ms} = 41\%$

Market Surplus Maximizing Price of $1,581
Market Surplus Maximizing Allocation

$p_{ms} = $1581

$s_{ms} = 41\%$

$C(s)\quad D(s)\quad$
Mandate lowers market surplus by $45

Welfare Cost of Mandates: Market Surplus

- $182
- $227
Ex-Ante WTP: General Model

What about Ex-Ante WTP?

Paper provides generalized model that incorporates:

- **Moral Hazard**
  - Cost responds to insurance coverage
  - WTP can lie below cost

- **Preference Heterogeneity**

- **Imperfect information about costs**
  - Key advantage: yields internal measure of risk aversion
Marginal Ex-ante WTP for larger insurance market:

\[
\frac{W'(s)}{E[u_c]} = \frac{D(s) - C(s) + EA(s)}{E[u_c]} = \frac{D(s) + EA(s) - C(s)}{E[u_c]}
\]

where

\[EA(s) = (1 - s)(C(s) - D(s) - sD'(s))\beta(s)\]

and

\[\beta(s) = \frac{E[u_c|Insured] - E[u_c|Unins]}{E[u_c]}\]
General Formula for Ex-Ante WTP

Marginal Ex-ante WTP for larger insurance market:

\[
\frac{W'(s)}{E[u_c]} = D(s) - C(s) + EA(s) = D(s) + EA(s) - C(s)
\]

Market Surplus

"Ex-Ante" WTP

where

\[
EA(s) = (1 - s)(C(s) - D(s) - sD'(s))\beta(s)
\]

Size of Transfer

and

\[
\beta(s) = \frac{E[u_c|Insured] - E[u_c|Unins]}{E[u_c]}
\]

Marginal Utility Difference

Need to estimate \(\beta(s)\)
Implementation Assumptions

- **Step 1**: No complementarities/substitutability + common prefs:

\[
\beta(s) = \gamma [E[C(s')|s' \geq s] - E[C(s')|s < s']] \\
- \text{Where } \gamma = \frac{-u_{cc}}{u_c} \text{ is the CARA}

- **Step 2**: No liquidity / income differences between insured and uninsured

\[
\beta(s) = \gamma [D(s) - E[D(s')|s' \geq s]]
\]

- **Key additional input**: External/Internal measure of risk aversion
  - Baseline case: \( \gamma = 5 \times 10^{-4} \) (Handel, Hendel, and Whinston 2016)
From Observed to Ex-Ante Demand

\[ D(s) + E A(s) \]

\[ C(s) \]

\[ D(s) \]
From Observed to Ex-Ante Demand

$ p_{ea} = $1089

$ s_{ea} = 55% $
Result #1: Ex-ante optimal insurance prices are $1089 not $1581.

Ex-Ante Optimal Allocation involves "deadweight loss".

$\rho_{ea} = $1089

$s_{ea} = 55\%$
Everyone is WTP $228 to live in a world with marginal price of $1089 for insurance prior to learning $s$.
Welfare Cost of Mandates: Ex-Ante Welfare

Result #2:
Mandate increases ex-ante welfare by $70 (but lower market surplus by $45)

Welfare Cost of Mandates: Ex-Ante Welfare $ per year
Fraction Insured (s)
Non-Budget Neutral Policies: Modified MVPF

- For non-budget neutral policies, consider the marginal WTP per dollar of government revenue (MVPF)
  - Mayshar (1990); Hendren (2016)
  - Can be compared to the MVPF of alternative policies (e.g. EITC)

\[
MVPF = \frac{\text{Marginal WTP for Beneficiaries}}{\text{Marginal Cost to Govt}}
\]
Non-Budget Neutral Policies: Modified MVPF

- Insured value $1 lower premium at $1

- Implies

$$MVPF_{Ex-Post} = \frac{1}{1 + \frac{C(s) - D(s)}{sD'(s)}}$$

- But, prior to learning they will be insured, additional value

$$MVPF_{Ex-Ante} = \frac{E[u_c|Insured]}{E[u_c]} \cdot \frac{1}{1 + \frac{C(s) - D(s)}{sD'(s)}}$$

where

$$\frac{E[u_c|Insured]}{E[u_c]} = 1 - (1 - s)\beta(s)$$

- Two reasons $MVPF > 1$
  - $C(s)$ is above $D(s)$
  - Ex-ante value of insurance
MVPF for Additional Subsidies
Assumes Govt/Insurer Pays Uncompensated Care

MVPF is $0.50 higher from ex-ante perspective when 30% of market is insured.
Summary

- Insurance insures against the realization of risk
  - Revealed preference does not measure ex-ante notions of expected utility

- Paper provides method to measure ex-ante expected utility
  - Retain empirical transparency of reduced form WTP and cost curves
  - Augment with diff in marginal utilities between insured and uninsured

- Provide benchmark implementation method

- Requires minimal additional information
  - Exploiting WTP and cost curves
  - Risk aversion (internal or external)
Ex-Ante Perspective Can Change Value of Social Insurance

- Apply to low-income health insurance in Massachusetts
  - Ex-ante optimal prices are roughly 30% lower
  - Mandates increase expected utility despite increasing DWL
  - Higher marginal value of subsidies

Further applications: Other variation in choice sets

1. Valuing Medicaid or other social insurance using labor supply responses to eligibility notches [Keane and Moffitt 1998; Gallen 2014; Dague 2014]
   - Papers find low WTP for Medicaid
   - Capture only value of insurance against remaining risk when individuals adjust their labor supply to become eligible

2. Inferring WTP from consumption changes around a shock [Gruber 1997; Meyer and Mok 2013]
   - Consumption may not respond directly at the time we observe the shock, since some info may have been revealed [Hendren 2017]