Censored Quantile Instrumental Variable Estimates of the Price Elasticity of Expenditure on Medical Care

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NBER

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Motivation

- Medical care costs increasing
- Latest efforts to control costs focus on consumer price sensitivity

Research Questions

- How much does medical expenditure respond to the prices that consumers face?
- Does this response vary across the quantiles of the expenditure distribution?
Challenges to Estimation

1. **Skewness**
   - 95% of expenditures on 25% of individuals
   - Price responsiveness could vary from mean estimates

2. **Censoring**
   - 40% of individuals consume zero care
   - Traditional methods require parametric assumptions

3. **Endogeneity**
   - Price is a function of expenditure
   - RAND Health Insurance Experiment (1974-1982)
     randomized prices
My estimation approach: Censored Quantile Instrumental Variable

- **Censored**
  - 40% of individuals consume zero care
  - Traditional methods require parametric assumptions
  - CQIV handles censoring nonparametrically
- **Quantile**
  - 95% of expenditures on 25% of individuals
  - Price responsiveness could vary from mean estimates
  - CQIV allows for variable treatment effects, less sensitive to extreme values
- **Instrumental Variable**
  - Price is a function of expenditure
  - CQIV incorporates endogeneity with an instrumental variable
Strong price responsiveness at highest quantiles
Price elasticity of expenditure stable from .65 to .95 quantile at -2.3
Plan for Presentation

1. Introduction
2. Results
   - Graphical Results
   - CQIV
   - Other Estimators
3. Beyond Main Results
   - Robustness Tests
   - Heterogeneity
   - RAND Comparison
Instrumental Variable Identification Strategy

- **Relationship of Interest:** \( E = f(P) \)
  - \( E \) Expenditure on medical care by year-end (beneficiary + insurer)
  - \( P \) Marginal year-end price
- **Problem:**
  - Endogeneity: \( E = f(P(E)) \)
- **Solution:**
  - Instrument \( Z \) such that \( P = g(Z) \)
Marginal Pricing for Medical Care

CQIV
Estimates of the Price Elasticity of Expenditure on Medical Care
Amanda E. Kowalski

Introduction
Motivation
Identification
Pricing & Instrument
Data
Results
Beyond Main Results
Conclusion

Total Beneficiary Payments
Cost Sharing for Individuals

price = 0

Stoploss

price = Coinsurance

Deductible

price = 1

Deductible

[(Stoploss - Deductible)/Coinsurance] + Deductible

Total Beneficiary + Insurer Payments (E)
Family Pricing Interactions

- Individual Deductible: $500
- Family Deductible: $1,500
Instrumental Variable

\[ Z = 1 \text{ if family member has injury in given categories} \]

- Intracranial
- Superficial
- Crushing
- Foreign Body
- Burn
- Complications of Trauma
- Injuries to the Nerves and Spinal Cord
Advantages
- Large firm in the US retail trade industry - over 500,000 insured employees
- Large cross-section of people under age 65
- Plans vary only in deductible and stoploss

Limitations
- Do not observe insurance options outside the firm
- Do not observe income
- Do not observe premium
### Empirical Family Pricing Interactions

<table>
<thead>
<tr>
<th>Cost Sharing Comparison</th>
<th>Plan A</th>
<th>Plan B</th>
<th>Plan C</th>
<th>Plan D</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Deductible</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Individual</td>
<td>$350</td>
<td>$500</td>
<td>$750</td>
<td>$1,000</td>
</tr>
<tr>
<td>Family</td>
<td>$1,050</td>
<td>$1,500</td>
<td>$2,250</td>
<td>$3,000</td>
</tr>
<tr>
<td><strong>Stoploss (Includes Deductible)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Individual</td>
<td>$2,100</td>
<td>$3,000</td>
<td>$4,500</td>
<td>$6,000</td>
</tr>
<tr>
<td>Family</td>
<td>$4,550</td>
<td>$6,500</td>
<td>$9,750</td>
<td>$10,000</td>
</tr>
<tr>
<td><strong>Coinsurance (Beneficiary)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>In-Network</td>
<td>20%</td>
<td>20%</td>
<td>20%</td>
<td>20%</td>
</tr>
<tr>
<td>Out-of-Network</td>
<td>40%</td>
<td>40%</td>
<td>40%</td>
<td>40%</td>
</tr>
</tbody>
</table>
Empirical Cost Sharing for Individuals

Sample includes 2004 employees in couples in $500 deductible plan.
Graph depicts 97.5% of observations.
Observations with total beneficiary payments greater than $3,100 omitted.
Observations with total beneficiary and insurer payments greater than $21,000 omitted.
Sample Selection

- Families of four or more
- All family members continuously enrolled January 1-December 31
- 2004 final estimation sample: 127,119 individuals in 29,010 families
## Summary Statistics

### 2004 Employee Sample

<table>
<thead>
<tr>
<th>Year-end Expenditure ($)</th>
<th>% Sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>35.7</td>
</tr>
<tr>
<td>.01 to 100</td>
<td>11.0</td>
</tr>
<tr>
<td>100.01 to 1,000</td>
<td>31.1</td>
</tr>
<tr>
<td>1,000.01 to 10,000</td>
<td>19.0</td>
</tr>
<tr>
<td>10,000.01 to 100,000</td>
<td>3.2</td>
</tr>
<tr>
<td>100,000.01 and up</td>
<td>0.0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Year-end Price</th>
<th>% Sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>0  (Met Deductible &amp; Stoploss)</td>
<td>3.9</td>
</tr>
<tr>
<td>0.2 (Met Deductible)</td>
<td>38.8</td>
</tr>
<tr>
<td>1  (Did Not Meet Deductible)</td>
<td>57.3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Family Injury</th>
<th>% Sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 (NO Family Injury)</td>
<td>86.6</td>
</tr>
<tr>
<td>1 (Family Injury)</td>
<td>13.4</td>
</tr>
</tbody>
</table>
Plan for Presentation

1. Introduction
2. Results
   - Graphical Results
   - CQIV
   - Other Estimators
3. Beyond Main Results
   - Robustness Tests
   - Heterogeneity
   - RAND Comparison
Graphical Results

- Reduced form
  - Effect of family injury on expenditure
- First stage
  - Effect of family injury on price
CDF's by Family Injury

Reduced Form

First Stage

Higher Expenditure

Lower Year-end Price
Plan for Presentation

1. Introduction

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   - Robustness Tests
   - Heterogeneity
   - RAND Comparison
Introducing CQIV

- Random Coefficients by Quantile
  - Conversion to Elasticity Estimates
- Nonparametric Handling of Censoring
- Endogeneity with Control Function Approach
CQIV Random Coefficients by Quantile

Linear Model for Estimation:

\[
\begin{align*}
\ln E &= \max(\ln E^*, C) = T((\ln E_i)^*) \\
(\ln E)^* &= \alpha(U)P + W'\beta(U) + \gamma(U)V \\
P &= \phi(V, W, Z) \\
U &\sim U(0, 1)|P, W, C, V.
\end{align*}
\]

where \(\alpha(U)\) are the random coefficients of interest.
Random Coefficients by Quantile Conversion to Elasticity Estimates

General Arc Elasticity

\[ \eta_{arc} = \frac{\ln(\frac{y_a}{y_b})}{\ln(\frac{a}{b})}. \]

Arc Elasticity from \( P = 1 \) to \( P = .2 \)

\[ \hat{\eta} = \frac{\ln(E|P = 0.2) - \ln(E|P = 1)}{\ln(\frac{0.2}{1})} = \frac{\hat{\alpha}(0.2 - 1)}{\ln(\frac{0.2}{1})} \approx .50\hat{\alpha}. \]
CQIV Censoring - Nonparametric

- General Quantile Objective (no endogeneity)
  \[ \hat{\theta}(\tau) \text{ minimizes} \sum_{i=1}^{n} \rho_{\tau}(Y_i - X_i'\theta). \]

- Censored Quantile Objective (no endogeneity)
  \[ \hat{\theta}(\tau) \text{ minimizes} \sum_{i=1}^{n} \rho_{\tau}(Y_i - T(X_i'\theta)). \]

  where \( \rho_{\tau}(u) = \{(1 - \tau)1(u < 0) + \tau 1(u > 0)\}|u| \).

- Problem: The censored quantile objective function is not well-behaved because of the transformation function \( T() \).
Censoring with CQIV II

Based on Chernozhukov and Hong (2002) computational algorithm:

1. Parametrically predict which observations are less likely to be censored based on X’s.
2. Estimate the quantile regression on this sample. Based on prediction, select observations with prediction above censoring point.
3. Estimate the quantile regression on this expanded sample.
Control function approach

- Endogeneity between $P$ and $(\ln E)^*$ results in a lack of orthogonality between $P$ and structural disturbance $U$.
- Estimates based on the structural equation alone would be inconsistent.
- Following Hausman (1978), if $Z \perp U|W, X$, then $E(U|V) = \delta V + \eta$.
- By construction, $E(\eta|V) = 0$.
- Therefore, including the control term $\hat{V}$ in the structural equation eliminates the lack of orthogonality - it “controls” for endogeneity.
Main CQIV Elasticities

CQIV Price Elasticities – 2004 Employee Sample

Quantile

CQIV Price Elasticities

CQIV Main Elasticities

-2.6

Lower Bound

Elasticity

Upper Bound

60 70 80 90 100

-2.9

-2.6

-2.3

-2.0

-1.8

-2.6

-2.3

-2.0

-1.8

-2.9

-2.6

-2.3

-2.0

-1.8

60 70 80 90 100

-2.6

-2.3

-2.0

-1.8

-2.6

-2.3

-2.0

-1.8

-2.9

-2.6

-2.3

-2.0

-1.8

-2.9

-2.6

-2.3

-2.0

-1.8

-2.9

-2.6

-2.3

-2.0

-1.8

-2.9

-2.6

-2.3

-2.0

-1.8

-2.9

-2.6

-2.3

-2.0

-1.8

-2.9

-2.6

-2.3

-2.0

-1.8

-2.9

-2.6

-2.3

-2.0

-1.8

-2.9

-2.6

-2.3

-2.0

-1.8

-2.9

-2.6

-2.3

-2.0

-1.8

-2.9

-2.6

-2.3

-2.0

-1.8

-2.9

-2.6

-2.3

-2.0

-1.8

-2.9

-2.6

-2.3

-2.0

-1.8

-2.9

-2.6

-2.3

-2.0

-1.8

-2.9

-2.6

-2.3

-2.0

-1.8

-2.9

-2.6

-2.3

-2.0

-1.8

-2.9

-2.6

-2.3

-2.0

-1.8

-2.9

-2.6

-2.3

-2.0

-1.8

-2.9

-2.6

-2.3

-2.0

-1.8

-2.9

-2.6

-2.3

-2.0

-1.8

-2.9

-2.6

-2.3

-2.0

-1.8

-2.9

-2.6

-2.3

-2.0

-1.8

-2.9

-2.6

-2.3

-2.0

-1.8

-2.9

-2.6

-2.3

-2.0

-1.8
## Main CQIV Elasticities

### 2003 CQIV Year-End Price Coefficients for Various Samples

Dependent variable: Ln(Expenditure)

<table>
<thead>
<tr>
<th>2004 Employee</th>
<th>65</th>
<th>70</th>
<th>75</th>
<th>80</th>
<th>85</th>
<th>90</th>
<th>95</th>
</tr>
</thead>
<tbody>
<tr>
<td>lower bound</td>
<td>-2.57</td>
<td>-2.56</td>
<td>-2.58</td>
<td>-2.53</td>
<td>-2.60</td>
<td>-2.63</td>
<td>-2.49</td>
</tr>
<tr>
<td>upper bound</td>
<td>-1.65</td>
<td>-1.77</td>
<td>-1.80</td>
<td>-1.97</td>
<td>-2.01</td>
<td>-2.10</td>
<td>-2.09</td>
</tr>
</tbody>
</table>

N=29,010
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Comparison to Other Estimators

- **Preview of Conclusions From Comparison**
  - Elasticity large regardless of estimator
  - Tobit IV assumptions are restrictive
  - Endogeneity biases estimate away from zero

- **Mean Estimates for Comparison to CQIV**
  - Tobit IV, Tobit, Truncated model, 2-part model
  - Mean estimate based on quantile estimates
  - Estimates from the literature

- **Quantile vs. Mean Estimates**
  - Estimate different quantities
  - Similar if underlying treatment effect is linear and error distribution is symmetric and homoskedastic
  - Unlikely to be the same in this application given censoring and skewness
  - CQIV requires no parametric assumptions for censoring, less sensitive to extreme values
Comparison of CQIV to Tobit IV and Tobit

### 2003 CQIV Year-End Price Coefficients for Various Samples

<table>
<thead>
<tr>
<th>Dependent variable: Ln(Expenditure)</th>
<th>Censored Quantile IV</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>2004 Employee</strong></td>
<td></td>
</tr>
<tr>
<td>65</td>
<td>70</td>
</tr>
<tr>
<td>lower bound</td>
<td>-2.57</td>
</tr>
<tr>
<td>upper bound</td>
<td>-1.65</td>
</tr>
<tr>
<td>N=29,010</td>
<td></td>
</tr>
</tbody>
</table>

- **Tobit (IV) assumptions**
  - Tobit: error normal and homoskedastic
  - Tobit IV: homoskedastic first stage error, join normality of structural and first stage error

- **Hausman test comparison** of Tobit IV to CQIV rejects null hypothesis that assumptions hold
- Tobit estimate of $-4.1$ implies that endogeneity biases estimate away from zero
Other Comparisons

CQIV Estimate: $-2.3$

- Traditional censored estimators
  - Truncated model with IV first stage: $-0.8$
  - Two part model with IV first stage: $-1.6$

- Mean estimate based on CQIV estimates
  - $(1 - .65) * -2.3 = -0.8$

- Estimates from the literature
  - Eichner (1997, 1998) Tobit IV: $-0.22$ to $-0.32$, $-0.8$
  - RAND: $-0.22$
    - Based on myopia assumption, discussed later
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Robustness Tests

- Couples Test
  - Indirect test of exclusion restriction

- Longitudinal test
  - Indirect test of exclusion restriction
  - Test of forward inter-year shifting hypothesis
Couples Test

- Indirect test of exclusion restriction
- No family pricing interaction in families of two
  - No first stage possible
  - Estimate reduced form instead of IV
## Couples Test Results

<table>
<thead>
<tr>
<th>Dependent variable: Ln(Expenditure)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Censored Quantile Regression</td>
</tr>
<tr>
<td>65  70  75  80  85  90  95  Tobit</td>
</tr>
</tbody>
</table>

### A. Employees in Couples

<table>
<thead>
<tr>
<th>Family Injury</th>
<th>0.18</th>
<th>0.11</th>
<th>0.20</th>
<th>0.13</th>
<th>0.03</th>
<th>-0.03</th>
<th>-0.08</th>
<th>0.43</th>
</tr>
</thead>
<tbody>
<tr>
<td>lower bound</td>
<td>0.01</td>
<td>-0.06</td>
<td>0.01</td>
<td>-0.04</td>
<td>-0.15</td>
<td>-0.22</td>
<td>-0.30</td>
<td>0.17</td>
</tr>
<tr>
<td>upper bound</td>
<td>0.35</td>
<td>0.29</td>
<td>0.38</td>
<td>0.31</td>
<td>0.21</td>
<td>0.17</td>
<td>0.15</td>
<td>0.69</td>
</tr>
</tbody>
</table>

Includes zero: no yes no yes yes yes yes no

N=29,010
Mean Expenditure: $2,882.57

### B. Employees in Families of Four or More

<table>
<thead>
<tr>
<th>Family Injury</th>
<th>0.45</th>
<th>0.43</th>
<th>0.42</th>
<th>0.43</th>
<th>0.39</th>
<th>0.34</th>
<th>0.27</th>
<th>0.84</th>
</tr>
</thead>
<tbody>
<tr>
<td>lower bound</td>
<td>0.33</td>
<td>0.32</td>
<td>0.32</td>
<td>0.31</td>
<td>0.27</td>
<td>0.23</td>
<td>0.16</td>
<td>0.65</td>
</tr>
<tr>
<td>upper bound</td>
<td>0.58</td>
<td>0.53</td>
<td>0.53</td>
<td>0.55</td>
<td>0.52</td>
<td>0.45</td>
<td>0.38</td>
<td>1.02</td>
</tr>
</tbody>
</table>

Includes zero: no no no no no no no no

N=29,010
Mean Expenditure: $1,484.74

### C. Employees in Families of Four or with Injury to Spouse or No Family Injury

<table>
<thead>
<tr>
<th>Family Injury</th>
<th>0.50</th>
<th>0.44</th>
<th>0.48</th>
<th>0.46</th>
<th>0.43</th>
<th>0.34</th>
<th>0.31</th>
<th>0.89</th>
</tr>
</thead>
<tbody>
<tr>
<td>lower bound</td>
<td>0.25</td>
<td>0.22</td>
<td>0.26</td>
<td>0.20</td>
<td>0.15</td>
<td>0.10</td>
<td>0.07</td>
<td>0.50</td>
</tr>
<tr>
<td>upper bound</td>
<td>0.76</td>
<td>0.67</td>
<td>0.70</td>
<td>0.73</td>
<td>0.70</td>
<td>0.58</td>
<td>0.55</td>
<td>1.28</td>
</tr>
</tbody>
</table>

Includes zero: no no no no no no no no

N=25,884
Mean Expenditure: $1,442.12
Longitudinal Test

- Indirect test of exclusion restriction
- Injury in 2004 cannot affect price in 2003
  - If no violation, in 2003, individuals with family injuries in 2004 should spend much less than individuals with family injuries in 2003
- Investigation of intertemporal shifting
  - Potential forward-shifting of expenditures from 2003 to 2004 in response to injury
  - If forward shifting, in 2004, individuals with family injuries in 2003 should spend much less than individuals with family injuries in 2004
## Longitudinal Test Results

<table>
<thead>
<tr>
<th>N= 3,061</th>
<th>65</th>
<th>70</th>
<th>75</th>
<th>80</th>
<th>85</th>
<th>90</th>
<th>95</th>
<th>Tobit</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A. Dependent variable: Ln(Expenditure 2003)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2004 Family Injury Only</td>
<td>-0.16</td>
<td>-0.08</td>
<td>-0.10</td>
<td>-0.08</td>
<td>-0.07</td>
<td>-0.12</td>
<td>-0.19</td>
<td>-0.18</td>
</tr>
<tr>
<td>lower bound</td>
<td>-0.36</td>
<td>-0.31</td>
<td>-0.35</td>
<td>-0.31</td>
<td>-0.31</td>
<td>-0.35</td>
<td>-0.45</td>
<td>-0.55</td>
</tr>
<tr>
<td>upper bound</td>
<td>0.05</td>
<td>0.15</td>
<td>0.15</td>
<td>0.14</td>
<td>0.17</td>
<td>0.12</td>
<td>0.07</td>
<td>0.18</td>
</tr>
</tbody>
</table>

| **B. Dependent variable: Ln(Expenditure 2004)** | | | | | | | | |
| 2003 Family Injury Only | -0.15 | -0.02 | 0.03 | -0.06 | -0.06 | 0.02 | -0.08 | -0.17 |
| lower bound | -0.39 | -0.25 | -0.22 | -0.35 | -0.33 | -0.24 | -0.31 | -0.55 |
| upper bound | 0.09 | 0.21 | 0.28 | 0.24 | 0.21 | 0.29 | 0.16 | 0.20 |

Continuously Enrolled 2003-2004 Employee Sample
Restricted to Employees with Injuries in 2003 or 2004 (But Not Both).
Heterogeneity Across CQIV Specifications

- Variation across estimates is small relative to magnitude of main estimates
  - Heterogeneity in Sample
    - Employee only vs. Employee & Family
    - 2004 vs. 2003
  - Heterogeneity in Dependent Variable
    - All Expenditure vs. Outpatient Expenditure
  - Heterogeneity in Instrument
    - Spouse vs. Child Injuries
## Heterogeneity in Sample: Employees, Spouses, Children

Dependent variable: Ln(Expenditure)

<table>
<thead>
<tr>
<th>A. 2004 Employee</th>
<th>65</th>
<th>70</th>
<th>75</th>
<th>80</th>
<th>85</th>
<th>90</th>
<th>95 Tobit IV</th>
</tr>
</thead>
<tbody>
<tr>
<td>lower bound</td>
<td>-2.57</td>
<td>-2.56</td>
<td>-2.58</td>
<td>-2.53</td>
<td>-2.60</td>
<td>-2.63</td>
<td>-2.49</td>
</tr>
<tr>
<td>upper bound</td>
<td>-1.65</td>
<td>-1.77</td>
<td>-1.80</td>
<td>-1.97</td>
<td>-2.01</td>
<td>-2.10</td>
<td>-2.09</td>
</tr>
<tr>
<td>N</td>
<td>29,010</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>B. 2004 Employee &amp; Spouse</th>
</tr>
</thead>
<tbody>
<tr>
<td>Price Elasticity</td>
</tr>
<tr>
<td>lower bound</td>
</tr>
<tr>
<td>upper bound</td>
</tr>
<tr>
<td>N</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>C. 2004 Everyone</th>
</tr>
</thead>
<tbody>
<tr>
<td>Price Elasticity</td>
</tr>
<tr>
<td>lower bound</td>
</tr>
<tr>
<td>upper bound</td>
</tr>
<tr>
<td>N</td>
</tr>
</tbody>
</table>
### Heterogeneity in Sample: 2004 vs. 2003

**Dependent variable:** Ln(Expenditure)

<table>
<thead>
<tr>
<th></th>
<th>Censored Quantile IV</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A. 2004 Employee</strong></td>
<td></td>
</tr>
<tr>
<td>lower bound</td>
<td>-2.57 -2.56 -2.58 -2.53 -2.60 -2.63 -2.49 -3.71</td>
</tr>
<tr>
<td>upper bound</td>
<td>-1.65 -1.77 -1.80 -1.97 -2.01 -2.10 -2.09 -2.65</td>
</tr>
<tr>
<td>N=29,010</td>
<td></td>
</tr>
</tbody>
</table>

| **B. 2003 Employee** |                      |
| Price Elasticity    | -2.51 -2.43 -2.32 -2.17 -2.17 -2.16 -2.22 -3.77 |
| lower bound         | -2.95 -2.74 -2.61 -2.54 -2.45 -2.46 -2.48 -4.28 |
| upper bound         | -2.12 -2.05 -1.98 -1.83 -1.94 -1.90 -1.99 -3.27 |
| N=29,886            |                      |

| **C. 2003 Employee and Spouse** |                      |
| lower bound              | -3.10 -2.86 -2.69 -2.46 -2.40 -2.38 -2.44 -4.28 |
| upper bound              | -2.44 -2.29 -2.19 -2.05 -2.02 -2.03 -2.09 -3.55 |
| N=54,683                 |                      |

| **D. 2003 Everyone** |                      |
| Price Elasticity      | -2.36 -2.21 -2.12 -2.09 -2.06 -2.04 -2.07 -3.87 |
| lower bound           | -2.56 -2.36 -2.31 -2.24 -2.22 -2.15 -2.19 -4.14 |
| upper bound           | -2.18 -2.04 -1.95 -1.93 -1.94 -1.94 -1.96 -3.60 |
| N=131,815             |                      |
### Heterogeneity in Dependent Variable: All Expenditure vs. Outpatient Expenditure

#### 2004 Employee

**A. Baseline (Standard Quantiles)**

<table>
<thead>
<tr>
<th></th>
<th>65</th>
<th>70</th>
<th>75</th>
<th>80</th>
<th>85</th>
<th>90</th>
<th>95</th>
</tr>
</thead>
<tbody>
<tr>
<td>lower bound</td>
<td>-2.57</td>
<td>-2.56</td>
<td>-2.58</td>
<td>-2.53</td>
<td>-2.60</td>
<td>-2.63</td>
<td>-2.49</td>
</tr>
<tr>
<td>upper bound</td>
<td>-1.65</td>
<td>-1.77</td>
<td>-1.80</td>
<td>-1.97</td>
<td>-2.01</td>
<td>-2.10</td>
<td>-2.09</td>
</tr>
</tbody>
</table>

**A. Baseline Continued (Higher Quantiles)**

<table>
<thead>
<tr>
<th></th>
<th>96</th>
<th>97</th>
<th>98</th>
<th>99</th>
</tr>
</thead>
<tbody>
<tr>
<td>Price Elasticity</td>
<td>-2.31</td>
<td>-2.35</td>
<td>-2.40</td>
<td>-2.31</td>
</tr>
<tr>
<td>lower bound</td>
<td>-2.55</td>
<td>-2.63</td>
<td>-2.75</td>
<td>-2.82</td>
</tr>
<tr>
<td>upper bound</td>
<td>-2.08</td>
<td>-2.10</td>
<td>-2.05</td>
<td>-1.80</td>
</tr>
</tbody>
</table>

**B. Ln(Outpatient Expenditure)**

<table>
<thead>
<tr>
<th></th>
<th>65</th>
<th>70</th>
<th>75</th>
<th>80</th>
<th>85</th>
<th>90</th>
<th>95</th>
</tr>
</thead>
<tbody>
<tr>
<td>Price Elasticity</td>
<td>-2.04</td>
<td>-1.97</td>
<td>-1.99</td>
<td>-2.08</td>
<td>-2.10</td>
<td>-2.24</td>
<td>-2.13</td>
</tr>
<tr>
<td>upper bound</td>
<td>-1.71</td>
<td>-1.60</td>
<td>-1.65</td>
<td>-1.72</td>
<td>-1.80</td>
<td>-1.99</td>
<td>-1.88</td>
</tr>
</tbody>
</table>

N=29,010
### Introduction

### Results

#### Beyond Main Results

#### Robustness Tests

#### Heterogeneity

#### RAND Comparison

#### Conclusion

### CQIV

#### Estimates of the Price Elasticity of Expenditure on Medical Care

Amanda E. Kowalski

### Heterogeneity in Instrument: Spouse vs. Child Injuries

#### 2004 Employee

<table>
<thead>
<tr>
<th>A. Baseline</th>
<th>65</th>
<th>70</th>
<th>75</th>
<th>80</th>
<th>85</th>
<th>90</th>
<th>95</th>
<th>Tobit IV</th>
</tr>
</thead>
<tbody>
<tr>
<td>lower bound</td>
<td>-2.57</td>
<td>-2.56</td>
<td>-2.58</td>
<td>-2.53</td>
<td>-2.60</td>
<td>-2.63</td>
<td>-2.49</td>
<td>-3.71</td>
</tr>
<tr>
<td>upper bound</td>
<td>-1.65</td>
<td>-1.77</td>
<td>-1.80</td>
<td>-1.97</td>
<td>-2.01</td>
<td>-2.10</td>
<td>-2.09</td>
<td>-2.65</td>
</tr>
</tbody>
</table>

N=29,010

#### B. Injuries to Children Only

| upper bound     | -1.66 | -1.59 | -1.81 | -1.99 | -2.03 | -2.11 | -2.03 | -2.58 |

N=28,385

#### C. Injuries to Spouse Only

| Price Elasticity | -2.36 | -2.18 | -2.09 | -2.10 | -2.15 | -2.26 | -2.28 | -3.40 |
| upper bound     | -1.33 | -1.47 | -1.37 | -1.44 | -1.51 | -1.70 | -1.82 | -2.32 |

N=25,883
Plan for Presentation

1. Introduction
2. Results
   - Graphical Results
   - CQIV
   - Other Estimators
3. Beyond Main Results
   - Robustness Tests
   - Heterogeneity
   - RAND Comparison
Comparison to RAND

1. Calculation of RAND estimates
   - Assumes myopia
2. Evidence of forward-looking behavior in my data
3. Simulation assuming myopia when individuals are forward-looking
Calculation of RAND estimates

- Coinsurance: 0%, 25%, 75%, 95%
- Stoploss: $1,000 or less in 1974-1982 dollars
  - Met by approximately 20% overall
  - Met by 35% in least generous plan
  - Met by 70% with inpatient expenditure
- My plans: less than 4% meet stoploss
“In order to compare our results with those in the literature, however, we must extrapolate to another part of the response surface, namely, the response to coinsurance variation when there is no maximum dollar expenditure. Although any such extrapolation is hazardous (and of little practical relevance given the considerable departure from optimality of such an insurance policy), we have undertaken such an extrapolation rather than forego entirely any comparison with the literature.” (Manning et al. (1987), page 267)
RAND Elasticity Calculation

Keeler and Rolph (1982)

\[ \eta_{\text{midpoint}} = \frac{(e_1 - e_2)/(e_1 + e_2)}{(p_1 - p_2)/(p_1 + p_2)} \]

\[ \eta_{\text{RAND}} = \frac{(71 - 55)/(71 + 55)}{(25 - 95)/(25 + 95)} \approx -0.22 \]
Forward-Looking Behavior

- Individuals with high expenditure in the previous year should react less to the family injury.
Forward-Looking Behavior

CQIV
Estimates of the Price Elasticity of Expenditure on Medical Care
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Introduction
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Robustness Tests
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2004 Expenditure Before and After Month of First Family Injury Employees

- Low 2003: Mean (Expenditure Before/# Months Before) = 77.73
- High 2003: Mean (Expenditure After/# Months After) = 255.24
- Low 2003: Mean (Expenditure After/# Months Before) = 102.02
- High 2003: Mean (Expenditure After/# Months After) = 251.17

Sample includes 2,265 employees. Paired t test statistics before vs. after: Low 2003: t = -1.17 High 2003: t = .11.

Only people with first family injuries from February–November are included. Expenditure during month of first family injury omitted.
Simulation Exercise

1. Estimate using my data and method

\[ \ln E = \alpha P + W' \beta + u \]

2. Predict expenditures

\[ \hat{\ln E} = \hat{\alpha} P + W' \hat{\beta} \]

3. Alter predicted expenditures for some forward-looking group who will meet new lower stoploss

\[ \ln \tilde{E} = \hat{\alpha} \ast 0 + W' \hat{\beta} \]

4. Compare to original estimate
Using Tobit IV, elasticity is -3.2

Predict expenditures

Place approximately 20% of people into hypothetical plans where year-end marginal price is known to be zero - 6,015 people with no family injuries whose total family spending exceeds $5,500

New elasticity is -.34
Results

- Strong price responsiveness at highest quantiles
- Price elasticity of expenditure stable from .65 quantile to .95 quantile: -2.3

Future work

- Welfare analysis
- Optimal nonlinear structure of health insurance