The Estimation Power of Alternative Comorbidity Indexes

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Introduction

- Healthcare expenditures are strongly influenced by overall illness burden.
- Appropriate risk adjustment is required for correct policy analysis.

A common way of adjusting for overall illness burden is through the use of comorbidity indexes that identify coexisting conditions unrelated to the principal condition under study.

- Charlson comorbidity index
- Elixhauser index
- Chronic disease score.

Not much is known about using more than one comorbidity index in the same model because investigators have been concerned with possible multicollinearity.

Study Design and Methods

Data Source
- In 2004, this database contained information on more than 15 million persons who were covered by private insurance.

Study Period

Inclusion Criteria
- Individuals, age 12 and older
- Confirmatory diagnosis of migraine (ICD-9-CM 346.x) during the patient identification period.
- January 1, 2002 through December 31, 2003

At least one prescription for a triptan
At least six months of continuous enrollment preceding the first triptan prescription (index event)

Study Design and Methods (cont’d)

- At least 12 months of continuous enrollment following the index event
- Eligible for medical and drug benefits during the 18-month study period

Control Variables
- Age
- Gender
- Geographic region
- Year of patient identification
- Urban area flag
- Types of health insurance
- Specialty of treating physician

Dependent Variable
- 12-month total healthcare costs consisting of:
  - Inpatient costs
  - Emergency room (ER) costs
  - Outpatient services costs
  - Outpatient prescription drug costs

Comorbidity Indexes
- Charlson comorbidity index (CCI)
- Elixhauser index (EI)
- Chronic disease score (CDS)

Results

- Analytic sample consists of 47,743 migraine patients with triptan use.
- Table 1 shows the summary statistics for the sample.

Table 1. Sample Statistics (N = 47,743)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total cost ($1,000)</td>
<td>6,438 (2,521)</td>
</tr>
<tr>
<td>Age (yr)</td>
<td>45.4 (16.5)</td>
</tr>
<tr>
<td>Female</td>
<td>0.550</td>
</tr>
<tr>
<td>Urban area flag</td>
<td>0.475</td>
</tr>
<tr>
<td>Charlson comorbidity index (CCI)</td>
<td>1.38 (1.97)</td>
</tr>
<tr>
<td>Elixhauser index (EI)</td>
<td>0.174 (0.224)</td>
</tr>
<tr>
<td>Chronic disease score (CDS)</td>
<td>0.92 (1.09)</td>
</tr>
</tbody>
</table>

- The models were estimated for the training subsamples and ASPE was calculated for the test subsamples.

Results (cont’d)

- Each index measures things that cannot be explained by the other two indexes.
- Thus, including all three indexes in the same model would control for unmeasurable variation, whereas excluding any of them may create omitted variable bias in the model.

- In terms of ASPE, CCI has the best performance.
- According to pseudo-R-squares, EI explains more variation than the other indexes.
- When considered individually, the results are inconclusive.
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- When considered individually, the results are inconclusive.

Discussion and Conclusions

- Investors are reluctant to use more than one comorbidity index in a model because of possible multicollinearity.
- However, multicollinearity does not violate any assumption about the consistency of the estimators.
- Since multicollinearity violates none of the assumptions for a best linear unbiased estimator, the problem of multicollinearity is not well defined.
- Statistical inference depends on:
  - Its correlation with other variables in the model (multicollinearity).
  - The total sample variation in the variable of interest (micronumerosity).

Table 2 shows the coefficients, p-values, marginal effects, and estimated cost values according to each model.

- Table 3 shows the coefficients, p-values, marginal effects, and estimated cost values according to each model.
- According to ASPE results, Model 4 (CCI and EI) performs better than Model 5 (CCI and CDS).

Table 3. Coefficients and Marginal Effects

<table>
<thead>
<tr>
<th>Model</th>
<th>Variable</th>
<th>Coefficient</th>
<th>SE</th>
<th>p-value</th>
<th>Marginal Effect</th>
<th>Estimate Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>CCI</td>
<td>Age</td>
<td>0.132</td>
<td>0.004</td>
<td>&lt;0.0001</td>
<td>0.004</td>
<td>136</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>0.069</td>
<td>0.011</td>
<td>0.03</td>
<td>0.012</td>
<td>109</td>
</tr>
<tr>
<td></td>
<td>Urban area flag</td>
<td>-0.071</td>
<td>0.011</td>
<td>0.001</td>
<td>-0.011</td>
<td>-104</td>
</tr>
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<td>136</td>
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<tr>
<td></td>
<td>Elixhauser index (EI)</td>
<td>0.101</td>
<td>0.003</td>
<td>&lt;0.0001</td>
<td>0.003</td>
<td>112</td>
</tr>
<tr>
<td></td>
<td>Chronic disease score (CDS)</td>
<td>0.089</td>
<td>0.002</td>
<td>&lt;0.0001</td>
<td>0.002</td>
<td>93</td>
</tr>
</tbody>
</table>

- Corresponding incremental effects for EI are $1,500 to $2,724, and for CDS, $556 to $877.

Table 4. Comorbidity Score Performance

<table>
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<tr>
<th>Model</th>
<th>Comorbidity</th>
<th>Score</th>
<th>Marginal Effect</th>
<th>Estimate Cost</th>
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- According to informal rules of thumb, the minimum value for each index is 0.
- The maximum value for each index is 10.

- Among the combinations, Model 4 (EI and CDS) has the worst performance compared with Model 4 (EI and CDS) and Model 5 (CCI and CDS).

- In terms of pseudo-R-squares, Model 5 (CCI and CDS) is better.

- Best results are achieved by using Model 3 (CCI, EI, and CDS).
- Using ASPE to compare the models, the deviation of predicted versus actual costs in the test sample for Model 7 was only $127.

- Investigators are reluctant to use more than one comorbidity index in a model because of possible multicollinearity.

- However, multicollinearity does not violate any assumption about the consistency of the estimators.

- Since multicollinearity violates none of the assumptions for a best linear unbiased estimator, the problem of multicollinearity is not well defined.

References