Estimating the Monetary Benefits of Medicare Eligibility for Reducing the Symptoms of Dementia

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Outline: Estimating the Monetary Benefits of Medicare Eligibility for Reducing the Symptoms of Dementia

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1.1 Background to Dementia

- Dementia is a term used to describe various symptoms of cognitive decline, involving memory, language and thinking that are severe enough to affect daily activities.

- In 2015, worldwide, there were 897 million people aged 60 and over and 5.2% of these had dementia; and in North America, there were 147 million people over the age of 60 and 6.4% of these had dementia.

- Global costs of dementia were US$ 818 billion in 2015, up by 34% from 2010, in terms of mortality, loss of quality of life and the need for informal and formal caregiving services.

- Given the prevalence and costs of this disease, it is important that interventions for dementia be identified and evaluated using cost-benefit analysis (CBA) to assess whether they are socially worthwhile.

- At this time, there is no cure for dementia, in which case the main options are to delay its onset or mitigate the symptoms.

- However, treatment is still a possibility if dementia symptoms can be observed to be lowered by some intervention, which we show in this study.
1.2 Background to this Study

• This study is a companion piece to my CBA carried out on years of education (Brent, 2016 – hereafter referred to as “the education dementia CBA”).

• The education dementia CBA estimated how the symptoms of dementia were reduced for each year of schooling that a person had experienced and valued this reduction by the dependent living cost savings that were generated.

• The education dementia CBA was built on an extensive literature that reported that education was one of the few causal ways that dementia has been shown to be reduced.

• The challenge is to identify and quantify the benefits of other interventions that can be shown to have a causal impact on dementia.

• In this regard a recent set of studies by Card et al. (2008, 2009) is important as it used a Regression Discontinuity (RD) approach to estimate the causal impact of Medicare for improving health care outcomes.

• This research revealed that accessing Medicare health insurance both increased health care utilization and saved lives via more visits to emergency departments for non-deferrable conditions.
1.2 Background to this Study (Cont.)

• Card et al. conjecture that Medicare might affect other dimensions of health than emergency visits and that these effects may persist over a longer period of time than the 9 months that they observed.

• This opens up the question whether something as widespread as dementia might also be something that Medicare eligibility can mitigate.

• To make progress on this issue, this study will analyze the effect of Medicare eligibility on dementia using RD methods to see if this can be classed as a causal intervention.

• We use a varying slopes RD version which shows how dementia is affected by age before and after the 65 years cutoff for Medicare eligibility.

• We then see if there are any monetary benefits that are forthcoming from reducing dementia in this way. To do this monetarization part we will use, and adapt, the three component cost-savings benefits method that was first used for the education dementia CBA.

• The adaption involves using a quality of life measure to estimate the extent to which any dementia reduction leads to changes in dependent living which generates the cost savings.

• We will directly estimate the effectiveness of Medicare eligibility for reducing dementia, and the consequential changes in dependent living arrangements, using a national data set on dementia.
2.1 Data Source

- The data we will be using to estimate the benefits of education for reducing dementia comes from the National Alzheimer’s Coordinating Center (NACC).

- NACC has constructed a data set that has been fully operational since 2005.

- These data consist of demographic, clinical, diagnostic, and neuropsychological information on participants with normal cognition, mild cognitive impairment, and dementia at 32 US Alzheimer’s Disease Centers (ADC).

- This data set was also used for the education dementia CBA and is fully explained elsewhere (Beekly et al. (2007)).

- This study uses the initial visit data for 17,239 participants collected between September 2005 and May 2015.
2.2 Measure of Dementia

- Brain pathology (such as plaques on the outside of the neurons or fibers on the inside of brain cells for AD, or lesions for vascular dementia) likely occurs many years before the onset of clinical dementia.

- This means that brain pathology is not a sufficient condition for a diagnosis of dementia.

- It may also not be a necessary condition as one can have cognitive impairment without the brain pathology.

- So we employ a measure of dementia that focuses on cognitive functioning rather than pathology.

- The instrument we use to measure dementia is the Clinical Dementia Rating (CDR) scale.

- The CDR is a measure of dementia severity used globally based primarily on a neurological exam and informant reporting and this was administered to each NACC participant at each visit by a clinician.

- There are six domains in the CDR: memory, orientation, judgment and problem solving, community affairs, home and hobbies, and personal care. Each domain is assessed using a 0 to 3 interval.

- The CDR-SB (the CDR sum of boxes) is the aggregate score across all six domains and this has a range of 0 to 18. This measure was also used in the education dementia CBA.
2.3 Measure of Quality of Life

- The Quality of Life (QoL) measure that is in the NACC data set that we will be using as a negative proxy for utility is the Geriatric Depression Scale (GDS), short form.

- There is a clinician interviewing the patient who decides whether the person is or is not able to complete the GDS rating.

- Irrespective of the severity of dementia, it was found that around 95% were capable of completing the GDS scale in our data set.

- Although the GDS was originally conceived to be a measure of psychological status, it has become accepted to be a generally valid measure of QoL among very old people with and without cognitive impairment. There are 15 ingredients in the GDS and we take the sum.

- That the GDS is an appropriate measure of QoL can be seen directly from two of its constituent ingredients which asks whether patients are basically satisfied with their life and whether they feel happy most of the time.

- Often these happiness and satisfaction measures are the sole ingredient of a QoL index.
3.1 Three Components for the Benefits

- Let:

\[ M \] stand for being eligible for Medicare,
\[ D \] stand for measured dementia,
\[ Li \] stand for the type of independent living, and
\[ C \] stand for the caregiving costs.

The three-step method involves applying the chain rule:

\[
\frac{\partial C}{\partial M} = \sum_i \frac{\partial C}{\partial Li} \frac{\partial Li}{\partial D} \frac{\partial D}{\partial M} \quad (1)
\]

- Where:

\[
\frac{\partial C}{\partial M} \text{ is the cost savings benefits from being eligible for Medicare,}
\frac{\partial C}{\partial Li} \text{ is the cost change per change in independent living,}
\frac{\partial Li}{\partial D} \text{ is the change in independent living per unit change in dementia symptoms, and}
\frac{\partial D}{\partial M} \text{ is the change in dementia symptoms from being eligible for Medicare.} 
\]
3.1 Three Components for the Benefits (Cont.)

- There will be four levels of living independence:

  \[ L_i \ (i = 1, 2, 3, 4). \]

- \( L_1 \) is when the person is living independently and does not need any caregiving and therefore caregiving costs are zero. There are three levels of non-independent living.

- \( L_2 \) is where the person needs some assistance and

- \( L_3 \) is where the person needs a lot of assistance.

- Persons in \( L_4 \) are completely dependent on caregivers.

- When Medicare reduces dementia, it results in people transitioning from levels \( L_2, L_3 \) and \( L_4 \) to \( L_1 \) and thereby saving the caregiving costs associated with non-independent living.

- The cost savings for \( L_4 \) persons is the greatest and the cost-savings is the least for \( L_2 \) persons.
3.1 Three Components for the Benefits (Cont.)

- With costs $C = C(Li)$, we have three dependent living cost changes to consider:

  $$\frac{\partial C}{\partial Li} = \frac{\partial C}{\partial L2}, \frac{\partial C}{\partial L3}, \frac{\partial C}{\partial L4}$$  \hspace{1cm} (2)

- The cost savings from reducing dementia from each of the three dependent living levels is then given by $(i = 2, 3, 4)$:

  $$\frac{\partial C}{\partial D} = \sum_i \frac{\partial C}{\partial Li} \frac{\partial Li}{\partial D}$$  \hspace{1cm} (3)

- In addition to knowing the unit cost declines as set out by equation (2), we need to know the extent to which reducing dementia impacts the independent living levels $\partial Li / \partial D$.

- We propose using the utility function relating $D$ to the $Li$. The utility function can be represented by $U = U(Li, D)$, from which we get, using the implicit function theorem:

  $$\frac{\partial Li}{\partial D} = (\overline{-}) \frac{\partial U}{\partial D} \div \frac{\partial U}{\partial Li}$$  \hspace{1cm} (4)

- Thus, the effect of $D$ on the $Li$ will be obtained as the marginal rate of substitution MRS between $D$ and the $Li$ in the utility function.
3.2 Estimation Framework

- We will use data to estimate the second and third components of the benefits method and rely on estimates in the literature for the first component involving the living costs laid out in equation (2).

- For the second component involving the MRS in equation (4) we need a specification of the utility function $U = U(L_i, D)$. We take a linear approximation as our regression equation of the form:

$$U = \alpha_0 + \alpha_D D + \alpha_2 L_2 + \alpha_3 L_3 + \alpha_4 L_4 + \alpha_Z Z + \varepsilon$$  \hspace{1cm} (5)

Where the $\alpha$'s are fixed coefficients and $\varepsilon$ is the random error term.

- $L_i$ is a categorical variable and this is represented by the three dummy variables $L_2$, $L_3$ and $L_4$. Independent living $L_1$ is excluded from the regression and is the reference category.

- Apart from the dementia variable $D$ and the independent living variables $L_i$ we include a vector of $Z$ variables as controls. Note that Medicare $M$ is also one of the controls.

- From equation (5) we derive the second component:

$$\frac{\partial L_2}{\partial D} = \frac{\alpha_D}{\alpha_2}; \quad \frac{\partial L_3}{\partial D} = \frac{\alpha_D}{\alpha_3}; \quad \text{and} \quad \frac{\partial L_4}{\partial D} = \frac{\alpha_D}{\alpha_4}$$  \hspace{1cm} (6)
3.2 Estimation Framework (Cont.)

- The third component involves estimating the effectiveness of Medicare in reducing dementia.

- Unlike equation (5) which is simply a descriptive representative of the utility function, to estimate the effect of $M$ on $D$ we need to use a causal model and employ an identification strategy.

- Our identification strategy will involve using the Regression Discontinuity RD approach.

- To implement the RD: The treatment variable is $M = 1$ when the person is aged 65 or over. $(\text{Age} - 65)$ is the assignment variable. The interaction $(\text{Age} - 65) \times M$ allows for the slope to vary before and after the age of 65 years.

- The RD equation with the non-Medicare $Z$ controls added is:

$$D = \beta_0 + \beta_1 M + \beta_2 (\text{Age} - 65) + \beta_3 (\text{Age} - 65) \times M + \beta_2 Z + \nu$$

(7)

Where the $\beta$’s are fixed coefficients and $\nu$ is now the random error term.

- From estimating this equation we obtain the third component: $$\frac{\partial D}{\partial M} = \beta_1$$

(8)
### 3.3 Effect on GDS of CDR-SB and Independent Living: Dependent Variable with Estimation Technique

<table>
<thead>
<tr>
<th>Variable</th>
<th>GDS Neg Bin</th>
<th>GDS2 Probit</th>
<th>GDS12 Probit</th>
<th>GDS15 Probit</th>
</tr>
</thead>
<tbody>
<tr>
<td>CDR-SB: $\alpha_D$</td>
<td>0.0416***</td>
<td>0.0096***</td>
<td>0.0037***</td>
<td>0.0057***</td>
</tr>
<tr>
<td></td>
<td>(6.11)</td>
<td>(4.82)</td>
<td>(4.00)</td>
<td>(7.77)</td>
</tr>
<tr>
<td>Independent</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Level 2: $\alpha_{L2}$</td>
<td>0.4026***</td>
<td>0.1377***</td>
<td>0.0549***</td>
<td>0.0361***</td>
</tr>
<tr>
<td></td>
<td>(8.72)</td>
<td>(8.21)</td>
<td>(6.40)</td>
<td>(5.14)</td>
</tr>
<tr>
<td>Independent</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Level 3: $\alpha_{L3}$</td>
<td>0.3464***</td>
<td>0.0992***</td>
<td>0.0698***</td>
<td>0.0481***</td>
</tr>
<tr>
<td></td>
<td>(5.81)</td>
<td>(3.75)</td>
<td>(5.40)</td>
<td>(3.97)</td>
</tr>
<tr>
<td>Independent</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Level 4: $\alpha_{L4}$</td>
<td>0.2165**</td>
<td>0.0633</td>
<td>0.0742***</td>
<td>0.0426***</td>
</tr>
<tr>
<td></td>
<td>(2.06)</td>
<td>(1.58)</td>
<td>(2.72)</td>
<td>(3.01)</td>
</tr>
<tr>
<td>Marital Status</td>
<td>$-0.1816***$</td>
<td>$-0.0246***$</td>
<td>$-0.0134***$</td>
<td>$-0.0251***$</td>
</tr>
<tr>
<td></td>
<td>(6.14)</td>
<td>(3.24)</td>
<td>(3.28)</td>
<td>(4.32)</td>
</tr>
<tr>
<td>Smoke</td>
<td>0.0040***</td>
<td>0.0011***</td>
<td>0.0005***</td>
<td>0.0001</td>
</tr>
<tr>
<td></td>
<td>(4.72)</td>
<td>(5.20)</td>
<td>(5.11)</td>
<td>(0.72)</td>
</tr>
<tr>
<td>Alcohol</td>
<td>$-0.2443***$</td>
<td>$-0.0553***$</td>
<td>$-0.0124$</td>
<td>$-0.0199***$</td>
</tr>
<tr>
<td></td>
<td>(4.74)</td>
<td>(4.57)</td>
<td>(1.29)</td>
<td>(2.85)</td>
</tr>
<tr>
<td>Heart Rate</td>
<td>0.0550***</td>
<td>0.0013***</td>
<td>0.0002</td>
<td>0.0002</td>
</tr>
<tr>
<td></td>
<td>(4.37)</td>
<td>(4.10)</td>
<td>(1.21)</td>
<td>(1.90)</td>
</tr>
<tr>
<td>Medicare $M$</td>
<td>$-0.3217***$</td>
<td>$-0.0732***$</td>
<td>$-0.0416***$</td>
<td>$-0.0295***$</td>
</tr>
<tr>
<td></td>
<td>(7.51)</td>
<td>(4.50)</td>
<td>(5.54)</td>
<td>(3.82)</td>
</tr>
<tr>
<td>Age – 65</td>
<td>0.0012</td>
<td>0.0027***</td>
<td>0.0009***</td>
<td>0.0005**</td>
</tr>
<tr>
<td></td>
<td>(0.65)</td>
<td>(3.72)</td>
<td>(3.24)</td>
<td>(2.04)</td>
</tr>
<tr>
<td>Constant</td>
<td>0.4942***</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(4.75)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pseudo $R^2$</td>
<td></td>
<td>0.0652</td>
<td>0.0639</td>
<td>0.0710</td>
</tr>
<tr>
<td>Sample Size $n$</td>
<td>14,751</td>
<td>14,747</td>
<td>14,738</td>
<td>14,740</td>
</tr>
</tbody>
</table>
### RD Analysis of Medicare on Dementia using OLS (t-stats in parentheses)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Varying Slopes RD Without Controls</th>
<th>Varying Slopes RD With Some Controls</th>
<th>Varying Slopes RD Model With Controls</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medicare ( M ): ( \beta_1 )</td>
<td>(-0.7690***) (3.214)</td>
<td>(-0.8168***) (3.65)</td>
<td>(-0.9182***) (4.44)</td>
</tr>
<tr>
<td>(Age – 65): ( \beta_2 )</td>
<td>0.0355*** (2.73)</td>
<td>0.0359*** (3.03)</td>
<td>0.0378 (3.20)</td>
</tr>
<tr>
<td>(Age – 65) ( \times M ): ( \beta_3 )</td>
<td>0.1234*** (4.90)</td>
<td>0.1017*** (4.39)</td>
<td>0.1079*** (4.41)</td>
</tr>
<tr>
<td>Male</td>
<td></td>
<td>0.6220*** (4.37)</td>
<td>0.3316*** (2.60)</td>
</tr>
<tr>
<td>Log Education</td>
<td></td>
<td>(-3.3032***) (10.36)</td>
<td>(-3.1402***) (9.80)</td>
</tr>
<tr>
<td>APOE (1 Copy)</td>
<td></td>
<td></td>
<td>1.8861*** (14.13)</td>
</tr>
<tr>
<td>APOE (2 Copies)</td>
<td></td>
<td></td>
<td>3.4314*** (19.29)</td>
</tr>
<tr>
<td>Sibling</td>
<td></td>
<td></td>
<td>0.3284*** (3.72)</td>
</tr>
<tr>
<td>Height</td>
<td></td>
<td></td>
<td>0.0498*** (3.81)</td>
</tr>
<tr>
<td>Constant</td>
<td>2.3319*** (8.43)</td>
<td>11.1048*** (12.19)</td>
<td>6.3712*** (5.15)</td>
</tr>
<tr>
<td>Pseudo R(^2)</td>
<td>0.0648</td>
<td>0.1147</td>
<td>0.1985</td>
</tr>
<tr>
<td>Sample Size ( n )</td>
<td>17,341</td>
<td>17,203</td>
<td>11,568</td>
</tr>
</tbody>
</table>
3.3 (Cont.) Plot for the Assignment Variable on CDR-SB
3.4 Three Components and Total Benefits: Using GDS to Measure Quality of Life for Component 2

The total benefits are $9,337 per Medicare eligible person.

Over half of this sum comes from the completely dependent living category L4, which is the most costly and therefore provides the greatest cost savings.

L4 is also the category of dependent living that is most affected by dementia being reduced.
4.1 Summary and Conclusions

• The method we used to monetize the benefits of Medicare eligibility involved estimating three components:

  (i) The extent to which an intervention lowered dementia as measured;
  (ii) The extent to which lowering dementia promotes more independent living; and
  (iii) The extent to which promoting independent living leads to caregiving cost savings.

• The methodological contribution of this study is that we estimated the second component by using a patient’s utility function and finding the MRS between dementia and dependent living in this utility function.

• In this way any cost savings came from changes in dependent living reflecting the preferences of the patients rather than a mechanical production function effect that has changed living conditions as an output corresponding to reductions in dementia as an input.

• For the third component we borrowed the RD identification strategy employed by Card et al. (2008, 2009) to estimate the health effects of having Medicare eligibility; and for the first component we adopted dependent living cost estimates coming from the dementia literature.

• Our best estimate of the total benefits of Medicare eligibility was around $9,337 per person in 2010 prices.
4.2 Summary and Conclusions (Cont.)

- To give some perspective on the size of these benefits, and to carry out the beginnings of a CBA, we can refer to the Medicare cost figures calculated by Zissimopoulos et al. (2015), Table 1.

- For 2010, the per capita Medicare annual cost per person was $10,904 if an individual aged 70+ did not have AD and it was $17,444 if the individual did have AD.

- The difference in these two cost figures, which is $6,540, approximates the additional cost to Medicare if someone’s dementia signs are not reduced.

- Compared to this cost, the estimated $5,029 benefits of Medicare eligibility lowering dementia are relatively large.

- The benefits of Medicare eligibility do not on their own outweigh the costs. But, Medicare eligibility has many types of health care benefits, as exemplified by the morality reductions found by Card et al. These monetary benefits need to be included.

- In addition, caregiver benefits have not been estimated in our study and these are also sizeable; one estimate has the benefits to caregivers of the complete prevention of AD at around $2,275 per year.