Disability and Multi-State Labour Force Choices with State Dependence

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Disability and Multi-State Labour Force Choices with State Dependence

Long term health conditions/disability that limits amount or type of work you can do. [Work Limitation]
Disability and Multi-State Labour Force Choices with State Dependence

$$y_{i,t} = f(y_{i,t-1}|X_{i,t}, D_{i,t}, \alpha_i)$$

Long term health conditions/disability that limits amount or type of work you can do. [Work Limitation]
Disability and Multi-State Labour Force Choices with State Dependence

\[ y_{i,t} = f(y_{i,t-1}|X_{i,t}, D_{i,t}, \alpha_i) \]

Long term health conditions/disability that limits amount or type of work you can do.
A Few Questions

• How does disability impact transitions within the labour force?

• Does State Dependence depend on (labour force) state?
  – What is the role of disability?
  – Is part time work a stepping stone?

• Is there a long run impact of a temporary disability?
  – Do skills matter?
Literature

• Static Binary Choice

• Static Multinomial Choice

• Dynamic Binary Choice
Contribution

• Dynamic multinomial choice model
  – Dynamic mixed multinomial logit with random effects

• Dynamic Interaction Model

• Model Simulations
  – Intertemporal Effect of Disability on Employment

• A Robustness Check
  – Fixed Effects Models with endogenous disability using GMM.
Data

• Household, Income and Labour Dynamics in Australia (HILDA), 2001-2007
• In 2001, 13,969 persons from 7,865 households are interviewed.
• Labour force, income, wealth, Socio-demographics, life events, Health, fertility, expectations...
Work Limitation Measure

• HILDA disability question:

“...do you have any long-term health condition, impairment or disability that restricts you in your everyday activities, and has lasted or is likely to last, for 6 months or more?”

• HILDA work disability question:

“Does your condition limit the type of work or the amount of work you can do?”
Sample

- Unbalanced sample of 1787 men and 1925 women
- Observed at least 3 consecutive waves in HILDA. (max 7 waves)
- Not in full-time education and Not eligible for Old Age Pension.
- 24-64 year old men
- 24-60 year old women
Employment by Work Limitation

**MEN**

**Not Limited**
- Full time: 84%
- Part time: 6%
- Unemployed: 2%
- NILF: 8%

**Limited**
- Full time: 34%
- Part time: 13%
- Unemployed: 4%
- NILF: 13%
Employment by Work Limitation

**WOMEN**

**Not Limited**
- Full time: 41%
- Part time: 36%
- Unemployed: 2%
- NILF: 21%

**Limited**
- Full time: 50%
- Part time: 25%
- Unemployed: 4%
- NILF: 21%
Transition across Employment States

State at $t+1$ - Men - Not Limited

State at $t+1$ - Men - Work Limited
Probability of Switching to Full time Employment Conditional on Initial Employment State and Disability

[Graphs showing transitions in employment status over time for different groups.]
Probability of Switching to Part time Employment Conditional on Initial Employment State and Disability
Dynamic Model

• Individual’s Labour Supply Problem for individual $i$ at time $t$:

$$\text{Max}_j U_j(\alpha_{i,j}, X_{i,t}, D_{i,t}, \Omega_{i,t-1}, \epsilon_{i,j,t})$$
Dynamic Model

- Individual’s Labour Supply Problem for individual $i$ at time $t$:

$$\max_j U_j(\alpha_{i,j}, X_{i,t}, D_{i,t}, \Omega_{i,t-1}, \epsilon_{i,j,t})$$

- Observed characteristics
  - Age, Age$^2$, Marriage, Kids,
  - Nonlabour income, education,
  - partner LF status, city,
  - occupation

- Health History up to $t$

- Employment History

$j = \text{Not in Labour Force, Unemployed, Part time, Full time}$
Dynamic Model

• Linear Approximation of utility of choosing employment state $j$.

$$y_{i,j,t} = \begin{cases} 
1 & \text{if } U_j(\alpha_{i,j}, X_{i,t}, D_{i,t}, \Omega_{i,t-1}, \epsilon_{i,j,t}) > U_k(\alpha_{i,k}, X_{i,t}, D_{i,t}, \Omega_{i,t-1}, \epsilon_{i,k,t}) \\
0 & \text{otherwise}
\end{cases}$$

$$y_{i,j,t} = \gamma_j y_{i,j,t-1} + \delta_{1,j} D_{i,t} + \delta_{2,j} D_{i,t-1} + \beta_1 x_{i,t} + \alpha_{i,j} + \epsilon_{i,j,t}$$
Dynamic Interaction Model

- Linear Approximation of utility of choosing employment state $j$.

$$y_{i,j,t} = 1 \begin{cases} 1 \text{ if } U_j(\alpha_{i,j}, X_{i,t}, D_{i,t}, \Omega_{i,t-1}, \epsilon_{i,j,t}) > U_k(\alpha_{i,k}, X_{i,t}, D_{i,t}, \Omega_{i,t-1}, \epsilon_{i,k,t}) \\ 0 \text{ otherwise} \end{cases}$$

$$y_{i,j,t} = \gamma_{j} y_{i,j,t-1} + \delta_{1,j}^* (y_{i,j,t-1} \times D_{i,t}) + \delta_{2,j} D_{i,t-1} + \beta_1 x_{i,t} + \alpha_{i,j} + \epsilon_{i,j,t}$$
Dynamic MMNL Model

• Linear Approximation of utility of choosing employment state $j$.

\[
y_{i,j,t} = \begin{cases} 
1 & \text{if } U_j(\alpha_{i,j}, X_{i,t}, D_{i,t}, \Omega_{i,t-1}, \epsilon_{i,j,t}) > U_k(\alpha_{i,k}, X_{i,t}, D_{i,t}, \Omega_{i,t-1}, \epsilon_{i,k,t}) \\
0 & \text{otherwise}
\end{cases}
\]

\[
y_{i,j,t} = \gamma_j y_{i,j,t-1} + \delta_{1,j} D_{i,t} + \delta_{2,j} D_{i,t-1} + \beta_1 x_{i,t} + \alpha_{i,j} + \epsilon_{i,j,t}
\]

(Alternative specific) Individual Unobserved Heterogeneity

\[
\alpha_i \sim I_3(0, \Sigma)
\]
Few Issues

• Random effects are too random

• Initial Conditions Problem
Few Issues

- Random effects are too random
- Initial Conditions Problem

\[ y_t = f(y_{t-1}, \alpha_i) \]
\[ = f(y_0, \alpha_i) \]

Data Starts

\( t = 0 \)
Few Issues: Likelihood Function

\[ \theta_i = C\alpha_i = B\eta_i; \quad \eta_i \sim N(0, I_3) \]

\[ L_i(\eta) = \prod_{j=1}^{J} P(j|x_{i,1}, \theta_{ij}) \prod_{t=2}^{T} \prod_{j=1}^{J} P(j|x_{i,t}, D_{i,t}, D_{i,t-1}y_{i,j,t-1}, \alpha_{i,j}) \]

\[ L = \prod_{i=1}^{N} \int_{-\infty}^{\infty} \int_{-\infty}^{\infty} \int_{-\infty}^{\infty} L_i(\eta_i)f(\eta_i)d(\eta_{i2})d(\eta_{i3})d(\eta_{i4}) \]
Few Issues: Likelihood Function

\[ \theta_i = C \alpha_i = B \eta_i; \quad \eta_i \sim N(0, I_3) \]

\[ L_i(\eta) = \prod_{j=1}^{J} P(j|x_{i,1}, \theta_{ij}) \prod_{t=2}^{T} \prod_{j=1}^{J} P(j|x_{i,t}, D_{i,t}, D_{i,t-1} y_{i,j,t-1}, \alpha_{i,j}) \]

\[ L = \prod_{i=1}^{N} \int_{-\infty}^{\infty} \int_{-\infty}^{\infty} \int_{-\infty}^{\infty} L_i(\eta_i) f(\eta_i) d(\eta_i) d(\eta_i^2) d(\eta_i^3) d(\eta_i^4) \]

The model is infeasible to estimate, unless we use...
Simulated Maximum Likelihood

• Steps:
  – Generate random draws
  – Convert to trivariate normal
  – Plug them into the likelihood function
  – Repeat...
    • Simulated Likelihood Function

\[ L_i^R = \frac{1}{R} \sum_{r=1}^{R} L_i(\eta_{ir}^r) \]
MMNL Results at a glance

• Dynamic Models
  – Highly significant own and cross state dependence
  – Highly significant current disability effect
  – REs significant except for unemployment
  – Unobserved factors are similar (but not the same) across states.

• Dynamic Interaction Models
  – Disability effect depends on past employment
    • except unemployment
## Average Partial Effects

<table>
<thead>
<tr>
<th>Dynamic Model</th>
<th>MEN</th>
<th>WOMEN</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>State at $t$</td>
<td>State at $t$</td>
</tr>
<tr>
<td></td>
<td>NILF</td>
<td>UNEMP</td>
</tr>
<tr>
<td>LPT</td>
<td>-34.12</td>
<td>-2.77</td>
</tr>
<tr>
<td>LUNE</td>
<td>-27.55</td>
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</tr>
<tr>
<td>LWORKLIM</td>
<td>0.90</td>
<td>-0.80</td>
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<tr>
<td>WORKLIM</td>
<td>8.26</td>
<td>1.07</td>
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</table>
## Average Partial Effects - Interaction Model

<table>
<thead>
<tr>
<th>State at t</th>
<th>NILF</th>
<th>UNEMP</th>
<th>PT</th>
<th>FT</th>
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<tbody>
<tr>
<td>MEN</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LFT</td>
<td>-42.52</td>
<td>-4.48</td>
<td>-10.28</td>
<td>57.28</td>
</tr>
<tr>
<td>LPT</td>
<td>-38.38</td>
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<td>30.57</td>
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<tr>
<td>LUNE</td>
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<td>3.82</td>
<td>-0.78</td>
<td>30.50</td>
</tr>
<tr>
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<td>-0.81</td>
<td>0.50</td>
<td>-0.49</td>
</tr>
<tr>
<td>WORKLIM</td>
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<td></td>
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</tr>
<tr>
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<td>1.19</td>
<td>2.88</td>
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<tr>
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<td>12.63</td>
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<tr>
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<td>-13.84</td>
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</table>

<table>
<thead>
<tr>
<th>State at t</th>
<th>NILF</th>
<th>UNEMP</th>
<th>PT</th>
<th>FT</th>
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<tbody>
<tr>
<td>WOMEN</td>
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<td></td>
<td></td>
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<tr>
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<td>-54.12</td>
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<td>-37.06</td>
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<tr>
<td>LPT</td>
<td>-1.48</td>
<td>-1.49</td>
<td>3.41</td>
<td>-0.33</td>
</tr>
<tr>
<td>LUNE</td>
<td>-12.88</td>
<td>43.13</td>
<td>9.37</td>
<td>-1.94</td>
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<td>68.48</td>
<td>9.54</td>
<td>24.28</td>
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<tr>
<td>WORKLIM</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>x LFT</td>
<td>5.54</td>
<td>2.35</td>
<td>4.79</td>
<td>-12.68</td>
</tr>
<tr>
<td>x LPT</td>
<td>9.27</td>
<td>0.84</td>
<td>-2.49</td>
<td>-7.62</td>
</tr>
<tr>
<td>x LUNE</td>
<td>10.25</td>
<td>3.38</td>
<td>3.09</td>
<td>-16.72</td>
</tr>
<tr>
<td>x LNILF</td>
<td>15.35</td>
<td>3.56</td>
<td>-6.67</td>
<td>-12.23</td>
</tr>
</tbody>
</table>
Model Simulations: The Design

• Simulating intertemporal effect of disability on average person’s choice probabilities
  – High skilled (BA+, white collar)
  – Low skilled (not BA+, blue collar)
  – Disability shock at t = 2
    • not disabled at t = 1 & t ≥ 3
Employment Response after Disability - High Skilled Persons

Male Employment Response after Disability - High Skilled

Women Employment Response after Disability - High Skilled
Employment Response after Disability - Low Skilled Persons

[Graphs showing employment response over time for men and women after disability.]
Conclusion

• Strong own and cross state dependence in labour force behaviour
• Large effect of disability on FT
• Small effect on UEMP and PT is due to opposite flows from other employment states
• Magnitude of effect depends on employment history
• Due to feedback effect temporary shock may have long lasting impacts
  – Different effect across gender and skill.
Endogeneity of Work Disability

• Justification bias + Measurement Error
• LPM with Fixed Effects estimated by GMM

\[ y_{i,t}^{FT} = \gamma_1 y_{i,t-1}^{FT} + \beta_1 Z_{it} + \beta_2 D_{it} + \beta_3 D_{i,t-1} + \eta_i^{FT} + \epsilon_i^{FT} \]

\[ y_{i,t}^{PT} = \gamma_2 y_{i,t-1}^{PT} + \beta_4 Z_{it} + \beta_5 D_{it} + \beta_6 D_{i,t-1} + \eta_i^{PT} + \epsilon_i^{PT} \]

\[ y_{i,t}^{UE} = \gamma_3 y_{i,t-1}^{UE} + \beta_7 Z_{it} + \beta_8 D_{it} + \beta_9 D_{i,t-1} + \eta_i^{UE} + \epsilon_i^{UE} \]

– can accommodate \( E[\eta_i, X_{it}] \neq 0 \) and \( E[D_{it}, \epsilon_{it}] \neq 0 \)
Endogeneity of Work Disability

• Justification bias + Measurement Error
• LPM with Fixed Effects estimated by GMM

\[ y_{i,t}^{FT} = \gamma_1 y_{i,t-1}^{FT} + \beta_1 Z_{it} + \beta_2 D_{it} + \beta_3 D_{i,t-1} + \eta_i^{FT} + \epsilon_{it}^{FT} \]

\[ y_{i,t}^{PT} = \gamma_2 y_{i,t-1}^{PT} + \beta_4 Z_{it} + \beta_5 D_{it} + \beta_6 D_{i,t-1} + \eta_i^{PT} + \epsilon_{it}^{PT} \]

\[ y_{i,t}^{UE} = \gamma_3 y_{i,t-1}^{UE} + \beta_7 Z_{it} + \beta_8 D_{it} + \beta_9 D_{i,t-1} + \eta_i^{UE} + \epsilon_{it}^{UE} \]

– Should watch out for Sargan and AR(2) tests
## RE vs FE

<table>
<thead>
<tr>
<th>MMNL</th>
<th>LPM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Own state dependence</td>
<td>✓</td>
</tr>
<tr>
<td>Cross state dependence</td>
<td>✓</td>
</tr>
<tr>
<td>Work Disability at t</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>✓ (PT, UNEMP)</td>
</tr>
<tr>
<td></td>
<td>✓ (PT, UNEMP)</td>
</tr>
</tbody>
</table>
EXTRAS
Joint Estimation

• Two-Equation Model

\[ y_{it} = \gamma y_{i,t-1} + X_{it}' \beta_1 + \delta_1 D_{it} + \delta_2 D_{i,t-1} + \alpha_i + \varepsilon_{it} \]

\[ D_{it} = \gamma_1 D_{i,t-1} + X_{it}' \beta_2 + \eta_i + \nu_{it} \]

\[(\alpha_i, \eta_i) \sim BVN(\sigma_1, \sigma_2, \rho)\]
Logit Probabilities

• Probability of Choosing State \( j \)

\[
P(j|X_{it}, \alpha_i) = \frac{\exp(y_{i,t-1,j}\gamma_j + X_{it}\beta_j + \delta_1 j D_{i,t} + \delta_2 j D_{i,t-1} + \alpha_{ij})}{\sum_{k=1}^{J} \exp(y_{i,t-1,k}\gamma_k + X_{it}\beta_k + \delta_1 D_{i,t} + \delta_2 k D_{i,t-1} + \alpha_{ik})}
\]
# Employment by Work Limitation

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<tr>
<th></th>
<th>MEN</th>
<th>WOMEN</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>Work Limited</td>
<td>Not Work Limited</td>
</tr>
<tr>
<td>FT</td>
<td>36.65</td>
<td>85.00</td>
</tr>
<tr>
<td>PT</td>
<td>13.03</td>
<td>8.10</td>
</tr>
<tr>
<td>UNEMP</td>
<td>4.21</td>
<td>2.00</td>
</tr>
<tr>
<td>NILF</td>
<td>46.11</td>
<td>4.90</td>
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</table>
### Transition across Employment States, Not Disabled

<table>
<thead>
<tr>
<th>State at t</th>
<th>State at t +1</th>
<th>State at t+2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>FT</td>
<td>PT</td>
</tr>
<tr>
<td>FT</td>
<td>95.12</td>
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<td>PT</td>
<td>29.90</td>
<td>61.18</td>
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<tr>
<td>UNEMP</td>
<td>45.16</td>
<td>14.52</td>
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<tr>
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<table>
<thead>
<tr>
<th>State t</th>
<th>State t +1</th>
<th>State t+2</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>FT</td>
<td>PT</td>
</tr>
<tr>
<td>FT</td>
<td>85.03</td>
<td>10.82</td>
</tr>
<tr>
<td>PT</td>
<td>14.58</td>
<td>76.45</td>
</tr>
<tr>
<td>UNEMP</td>
<td>19.16</td>
<td>32.24</td>
</tr>
<tr>
<td>NILF</td>
<td>3.21</td>
<td>19.40</td>
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</table>
## Transition across Employment States, Disabled

### MEN

<table>
<thead>
<tr>
<th>State at t</th>
<th>State at t+1</th>
<th>State at t+2</th>
</tr>
</thead>
<tbody>
<tr>
<td>FT</td>
<td>82.29</td>
<td>76.53</td>
</tr>
<tr>
<td>PT</td>
<td>13.43</td>
<td>19.58</td>
</tr>
<tr>
<td>UNE</td>
<td>6.10</td>
<td>12.50</td>
</tr>
<tr>
<td>NILF</td>
<td>3.16</td>
<td>2.99</td>
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### WOMEN

<table>
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<tr>
<th>State at t</th>
<th>State at t+1</th>
<th>State at t+2</th>
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</thead>
<tbody>
<tr>
<td>FT</td>
<td>73.32</td>
<td>69.88</td>
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<tr>
<td>PT</td>
<td>9.83</td>
<td>11.32</td>
</tr>
<tr>
<td>UNE</td>
<td>11.11</td>
<td>10.17</td>
</tr>
<tr>
<td>NILF</td>
<td>1.83</td>
<td>2.77</td>
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</tbody>
</table>
## Disability Transition

**MEN**

<table>
<thead>
<tr>
<th>State at $t$</th>
<th>$t+1$</th>
<th>$t+2$</th>
<th>$t+3$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not Limited</td>
<td>5.72</td>
<td>6.97</td>
<td>7.71</td>
</tr>
<tr>
<td>Limited</td>
<td>74.60</td>
<td>74.51</td>
<td>72.63</td>
</tr>
</tbody>
</table>

**WOMEN**

<table>
<thead>
<tr>
<th>State at $t$</th>
<th>$t+1$</th>
<th>$t+2$</th>
<th>$t+3$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not Limited</td>
<td>5.38</td>
<td>6.73</td>
<td>7.65</td>
</tr>
<tr>
<td>Limited</td>
<td>71.00</td>
<td>69.53</td>
<td>68.65</td>
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# Model Predictions

## Wave 2

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<tbody>
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<td>NILF</td>
<td>UNEMP</td>
</tr>
<tr>
<td>Actual</td>
<td>9.68</td>
<td>3.25</td>
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<tr>
<td>Static</td>
<td>6.72</td>
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<tr>
<td>Dynamic</td>
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<tr>
<td>Dynamic Int.</td>
<td>10.18</td>
<td>0.22</td>
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</table>
Motivation

• Disability $\rightarrow$ work, hours of work, wages

• Health $\sim$ Work Relationship is complex
  – Both outcome vary overtime
  – Unobserved heterogeneity
  – State dependence mask true effect of health
  – Long run effect of temporary shocks
  – *Endogeneity of self assessed health*