EXPLORING THE IMPACT OF NEW MEDICAL TECHNOLOGY ON WORKFORCE PLANNING*

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1. Background and Motivation

- Technological change is a significant and ongoing process in health care.

- An expansion effect occurs when the technology opens up new treatment possibilities that were previously unavailable (substitution or complementarity).

- **Impact on costs**
  - lower initial per unit cost of the new technology
  - increased total costs if more patients can be treated

- **Impact on the workforce** (is the up-take of medical innovation accompanied by a reduction in labour-intensive inputs?)
  - Many technological changes will be skill-biased

- **Impact on patient outcomes**
1. Background and Motivation

- This paper contributes to the existing literature on the diffusion of medical technologies.

- The **objective** is twofold.

1) Examine the substitution or complementarity effects of a new technology introduced into the NHS England.

2) Compute estimates of the degree to which the workforce reacts to the introduction of new technology, based on elasticity of supply measures.

*Understanding the effects of technological change is vital for workforce planning models*
2. Specific Technology

- Cardiologist perform —— Percutaneous Transluminal Coronary Angioplasty (PTCA)

- Cardiothoracic surgeons perform —— Coronary Artery Bypass Graft (CABG)
  
  - PTCA was introduced as a replacement for CABG.
  
  - PTCA is intended as a cheaper (per patient) and less invasive procedure

- This is an example of a consultant-led procedure replacing one performed by a surgeon.
2. Specific Technology
3. Workforce composition

- The increasing numbers for cardiothoracic surgeons is striking considering the decreasing trend in CABG.

- From 1999-2012, the average annual rate of growth was 6.8% for the doctors (all specialties), while it was 8.8% for cardiologists and 6.2% for cardiothoracic surgeons.
4. Data

• Two main datasets:

1) **Hospital Episode Statistics (HES):** includes all records from the financial year 1999/2000 to 2012/13 for each patient admitted into hospital for CABG or PTCA. Elective and emergency admissions.

2) **NHS Electronic Staff Records (ESR)** provides counts of FTE medical professionals by specialty and provider in each year.

• HES data aggregated at the provider level and year. The volume data was then merged with the ESR data to include the workforce information.

• The final dataset accounts for 79 providers from 1999/2000 to 2012/13.
5. Empirical Strategy

- **Equation 1**: diffusion equation that captures the elasticity of substitution or complementarity between CABG and PTCA. Static panel data model with fixed-effects (provider and year).

\[
\frac{PTCA}{pop45}_{it} = \alpha + \beta_1 \frac{CABG}{pop45}_{it} + (\beta_s - \beta_1)\left(\frac{CABG}{pop45}_{it} \cdot (t \epsilon s)\right) + \gamma' Z_{it} + d_t + c_i + u_{it} \tag{1}
\]

- PTCA and CABG volumes are adjusted by population at risk (over 45).

- *Statins*: are prescribed for primary and secondary prevention of cardiovascular disease. To alleviate this potential source of bias, we introduce the total number of statins prescribed at the PCT level.
5. Empirical Strategy

- **Equation 2:** quantify the elasticity between the workforce and the PTCA/CABG using a dynamic panel model (GMM Blundell & Bond).

\[
WF_{it} = \alpha + \beta_1 WF_{it-1} + \beta_2 \frac{PTCA}{CABG_{it}} + (\beta_s - \beta_2) \frac{PTCA}{CABG_{it}} * (t \epsilon s) + \gamma' Z_{it} + d_t + c_i + u_{it} \tag{2}
\]

- $WF_{it}$ is the ratio between two counts of different FTE in the workforce (skill mixed measures):

\[
C/CSCountry_{it} = \frac{Cardiologist_{it}/TotalCardiologist_{t}}{CardioSurgeons_{it}/TotalCardioSurgeons_{t}} \tag{3}
\]

- Equation 2 accounts for the lag of the dependent variable to control for any adjustment cost associated to workforce training (endogenous, need IV).
5. Results. Equation 1

<table>
<thead>
<tr>
<th></th>
<th>Dependent: PTCA/1000pop45+</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
</tr>
<tr>
<td>CABG/1000pop45+</td>
<td>0.690*** (0.202)</td>
</tr>
<tr>
<td>CABG/1000pop45+ * (2003-2007)</td>
<td>0.336*** (0.0586)</td>
</tr>
<tr>
<td>CABG/1000pop45+ * (2008-2012)</td>
<td>0.391*** (0.0951)</td>
</tr>
<tr>
<td>log Statins</td>
<td>-10.44** (4.041)</td>
</tr>
<tr>
<td>Constant</td>
<td>11.45** (4.833)</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th></th>
<th>868</th>
<th>357</th>
<th>363</th>
<th>144</th>
</tr>
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<tbody>
<tr>
<td>N</td>
<td>868</td>
<td>357</td>
<td>363</td>
<td>144</td>
</tr>
<tr>
<td>R²</td>
<td>0.442</td>
<td>0.523</td>
<td>0.416</td>
<td>0.583</td>
</tr>
<tr>
<td>Providers</td>
<td>79</td>
<td>29</td>
<td>76</td>
<td>29</td>
</tr>
<tr>
<td>Year fixed-effects</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Provider fixed-effects</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Controls Patients</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Controls Providers</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Notes: Robust standard errors in parentheses. Significance levels: *** p<0.01, ** p<0.05, * p<0.1.
5. Results. Equation 2

Table 3: Results Equation 2: Workforce - PTCA/CABG ratio

<table>
<thead>
<tr>
<th></th>
<th>C/CS</th>
<th>C/CS_consultant</th>
<th>C/CS_specialist</th>
<th>C/CS_trainees</th>
<th>C/nurses</th>
<th>CS/nurses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lag dependent</td>
<td>0.595***</td>
<td>0.611***</td>
<td>0.324***</td>
<td>0.468***</td>
<td>0.683***</td>
<td>0.680***</td>
</tr>
<tr>
<td></td>
<td>(0.0683)</td>
<td>(0.0672)</td>
<td>(0.0611)</td>
<td>(0.0768)</td>
<td>(0.0652)</td>
<td>(0.0890)</td>
</tr>
<tr>
<td>vol_PTCA/vol_CABG</td>
<td>0.0901***</td>
<td>0.0554*</td>
<td>0.0644</td>
<td>-0.00396</td>
<td>-0.0122</td>
<td>-0.106***</td>
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<tr>
<td></td>
<td>(0.0325)</td>
<td>(0.0306)</td>
<td>(0.0447)</td>
<td>(0.0351)</td>
<td>(0.0195)</td>
<td>(0.0338)</td>
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<tr>
<td>vol_PTCA/vol_CABG*</td>
<td>0.0204</td>
<td>0.00916</td>
<td>0.0125</td>
<td>-0.00586</td>
<td>0.00587</td>
<td>-0.0175</td>
</tr>
<tr>
<td>(2003-2007)</td>
<td>(0.0200)</td>
<td>(0.0189)</td>
<td>(0.0322)</td>
<td>(0.0406)</td>
<td>(0.0130)</td>
<td>(0.0178)</td>
</tr>
<tr>
<td>vol_PTCA/vol_CABG*</td>
<td>0.0479*</td>
<td>0.0354</td>
<td>0.0271</td>
<td>0.00990</td>
<td>0.00390</td>
<td>-0.0390*</td>
</tr>
<tr>
<td>(2008-2012)</td>
<td>(0.0253)</td>
<td>(0.0267)</td>
<td>(0.0354)</td>
<td>(0.0467)</td>
<td>(0.0168)</td>
<td>(0.0228)</td>
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<tr>
<td>Constant</td>
<td>-0.928</td>
<td>-1.598*</td>
<td>-1.023</td>
<td>-1.590</td>
<td>-1.348**</td>
<td>-1.491**</td>
</tr>
<tr>
<td></td>
<td>(0.862)</td>
<td>(0.865)</td>
<td>(1.116)</td>
<td>(1.081)</td>
<td>(0.677)</td>
<td>(0.708)</td>
</tr>
</tbody>
</table>

N: 789
Providers: 79
Year Dummies: Yes
Controls patients: Yes
Controls provider: Yes
Years: 1999-2012

Notes: Robust standard errors in parentheses. Significance levels: *** p<0.01, ** p<0.05, * p<0.1. Sargan test is not fulfilled for models of Column 3 and 6. The Abond test for autocorrelation is fulfilled for all models.
6. Discussion

• Regarding **diffusion (Equation 1)**, the results show a complementarity effect between CABG and PTCA (both adjusted by population at risk).

• *This is not in line with previous research.*

• *Reason:* time period of analysis. In our research, throughout the period, PTCA started to be considered as a more mature technology, while previous research has looked at previous periods, when it was considered a recently introduced technology.

• Statins show a negative and significant effect on the need for PTCA (substitution).
6. Discussion

- Regarding **workforce (Equation 2)**, the estimates show a positive and significant effect of the PTCA/CABG ratio on the workforce planning.

- As a result, the two technologies relationship (complementarity), is relevant to explain the number of FTE cardiologist and cardiothoracic surgeons.

- *This result was expected through the data!*

- However, it is mainly driven by the increase on the number of consultants rather than specialists or trainees.

*While our results are preliminary it would appear that the complex regulation of staffing and specialty mix is even further complicated once taking into account the impact of new technology.*
7. Further research

- We are still waiting for more disaggregated data for the workforce variables.

- We believe that controlling for wages and physicians characteristics (such as, age or gender) will improve our estimates.

- Further research will not only incorporate more specific data on workforce and PTCA/CABG, but it will also analyse other technologies.

- *For instance, the introduction of laparoscopic procedures in bariatric surgery or in prostatectomy interventions.*
THANKS FOR YOUR ATTENTION

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