THE DETERMINANTS OF PRESCRIBING INNOVATION BY PHYSICIANS:
PRESCRIBER CHARACTERISTICS VS. SOCIAL CONTAGION

Ágnes Lublóy – Judit Lilla Keresztúri – Gábor Benedek

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Presentation outline

• Motivation & research question

• Empirical analysis
  – Study drugs
  – Statistical model (Cox regression)
  – Independent variables
  – Results

• Conclusions
Motivation I.

Successful diffusion of new drugs are critical for a number of stakeholders.
Motivation II.

Understanding the mechanisms leading to prescribers’ early adoption of new drugs is important for several reasons:

- Accelerating diffusion
- Promoting cost-efficiency
- Forecasting utilization
- Developing targeted detailing and continuous medical education
Research question

Which factors determine the diffusion of new, innovative drugs for the treatment of type 2 diabetes mellitus?

Do social interactions with former classmates, scientific collaborators, and geographically close colleagues influence the likelihood of adoption equally?

Which prescribing characteristics predict new drug uptake consistently across various drugs from the same therapeutic class?
Contributions

Assessing the impacts of 3 types of social interaction: with former classmates, with scientific collaborators, and with geographically close colleagues

Investigating a wide range of potential additional determinants:

– No study analyzes such a wide variety of variables, or includes so many drugs from the same therapeutic class.
– Variables consistently predicting new drug diffusion within a therapeutic class are identified.
– Most influential categories of factors are identified.
– Prescription data instead of surveys and mail questionnaires
Empirical analysis: Study drugs

11 new drugs introduced between April 2008 and April 2010 for the treatment of type 2 diabetes mellitus

Lublóy – Keresztúri -Benedek: New drugs: Contagion vs prescriber characteristics
Method: Cox model (1972)

• Cox proportional hazards model (Cox 1972) is used to examine factors influencing the likelihoods of routine adoptions of new drugs by physicians.
• Proportional hazards models are a class of survival models in statistics which relate the time that passes until new drug uptake to several covariates that may be associated with that quantity of time.
• Data are censored from the right.

\[ h(t, x) = h_0(t, \alpha) \exp(\beta^T x) \]
Major data sources

**Prescription data: Doktorinfo Ltd.**
- For patients whose care is shared the ID number of the therapy-initiating physician is given. This information enables monitoring the adoption behaviors and prescribing patterns of physicians who share care of patients with diabetes.
- 321 sample physicians
- Routine adoption is investigated: adoption becomes routine when physicians first ask referring GPs to prescribe the new drug

**Socio-demographic and practice-related variables:**
- Office of Health Authorization and Administrative Procedures
Independent variables I.

25 variables in 6 categories of factors:

C1: Social embeddedness – contagion measures

• Assessing whether the adoption decisions of colleagues significantly influence SPs’ likelihoods of routine adoption.
• Time-dependent covariates: the percentage of adopting colleagues changing over time.
• Contagion measures which reflect distinct channels of interpersonal communication: with former classmates, with scientific collaborators, and with geographically close colleagues.
Network of classmates (SOTE)

Physicians: 94

Links: 141

Clusters: 28
Co-authorship network

Physicians: 93

Links: 170

Clusters: 13
Network based on geographic proximity

Physicians: 321

Links:
9 864

Clusters: 12
Independent variables II.

C2: Socio-demography

- Gender (male 47%, female 53%)
- Age (mean 42; min 32; max 78)
- Training location

C3: Scientific orientation

- Number of specialties (mean 1.78; min 1; max 4)
- Publication history (mean 2.14; min 0; max 136)
- Position (high 22.3%; low 44.3%)
- Strong scientific commitment (17 physicians)
Independent variables III.

C4: Prescribing patterns

• Prescribing intensity: mean number of prescription initiations per patient (mean 12.71; min 4.63; max 30.93)
• Portfolio width: number of brands prescribed for patients in shared care (mean 16.66; min 4; max 25)
• Insulin ratio (mean 79.1; min 0; max 100)
• Old A10B ratio (mean 2.99; min 0; max 33.3)

C5: Patient panel composition

• Age, gender, income, health status
Independent variables IV.

C6: Practice characteristics

- Number of patients (mean 123.48; min 14; max 784)
- Number of referring GPs (mean 21.56; min 1, max 84)
- Number of consultations (mean 1.68; min 1; max 2.85)
- Proportion of loyal patients (mean 70.8%; min 17.8; max 100%)
- Location (capital 21.7%; large city 28.6%; medium-sized city 14.8%; small city 34.9%)
- Type (clinic 10.7%; university/teaching hospital 11.6%; hospital 60.7; outpatient center and others 17.0%)
- Number of workplaces (number of the physicians’ current affiliations) (mean 1.46; min 1, max 5)
Results: Eucreas

Lublóy – Keresztúri -Benedek: New drugs: Contagion vs prescriber characteristics
### Contagion measures

<table>
<thead>
<tr>
<th></th>
<th>Actos</th>
<th>Byetta</th>
<th>Competact</th>
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<th>Xelevia</th>
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<tbody>
<tr>
<td><strong>Former classmates</strong></td>
<td>1,008</td>
<td>0,854 *</td>
<td>0,981</td>
<td>0,996</td>
<td>1,019</td>
<td>0,984 *</td>
<td>0,978</td>
<td>1,012</td>
<td>0,992</td>
<td>1,006</td>
<td></td>
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<tr>
<td><strong>Scientific collaborators</strong></td>
<td>0,972 †</td>
<td>0,077</td>
<td>0,990</td>
<td>1,000</td>
<td>0,950 *</td>
<td>1,003</td>
<td>0,968 *</td>
<td>0,797 **</td>
<td>1,033</td>
<td>1,081 †</td>
<td>0,913 *</td>
</tr>
<tr>
<td><strong>Geographic proximity (35 km)</strong></td>
<td>1,084 ***</td>
<td>1,198 *</td>
<td>1,047 *</td>
<td>1,031 *</td>
<td>1,052 **</td>
<td>1,033 *</td>
<td>1,044 **</td>
<td>0,922</td>
<td>1,010</td>
<td>0,972</td>
<td>1,006</td>
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<tr>
<td><strong>Geographic proximity (28 km)</strong></td>
<td>1,069 ***</td>
<td>1,160 †</td>
<td>1,027</td>
<td>1,035</td>
<td>1,044 **</td>
<td>1,036 *</td>
<td>1,040 **</td>
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<td>0,988</td>
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<td><strong>Geographic proximity (42 km)</strong></td>
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<td>1,193 †</td>
<td>1,047 †</td>
<td>1,032 *</td>
<td>1,057 **</td>
<td>1,040 *</td>
<td>1,042 **</td>
<td>0,895 †</td>
<td>4,010</td>
<td>0,959</td>
<td>1,008</td>
</tr>
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† p<0.1  *p<0.05  **p<0.001  ***p<0.0001
## Results: Socio-demography and scientific commitment

### Socio-demographic characteristics

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<tr>
<td><strong>Gender</strong></td>
<td>1,138</td>
<td>0,941</td>
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<td>0,900</td>
<td>0,881</td>
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<td>1,132</td>
<td>1,001</td>
<td>1,097</td>
<td>0,829</td>
<td>1,539 *</td>
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<td><strong>Age</strong></td>
<td>0,994</td>
<td>0,992</td>
<td>1,018 t</td>
<td>1,001</td>
<td>0,997</td>
<td>1,007</td>
<td>0,98 t</td>
<td>0,993</td>
<td>0,958 **</td>
<td>0,978 t</td>
<td></td>
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<tr>
<td><strong>Training location</strong></td>
<td>0,938</td>
<td>1,163</td>
<td>1,016</td>
<td>1,083</td>
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<td>0,985</td>
<td>0,980</td>
<td>0,957</td>
<td>1,079</td>
<td>0,999</td>
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### Scientific orientation

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<td>1,154 t</td>
<td>0,962</td>
<td>1,183 t</td>
<td>1,056</td>
<td>1,057</td>
<td>0,968</td>
<td>0,996</td>
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<td><strong>Publications</strong></td>
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<td>0,992</td>
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<td>0,988</td>
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<td>0,999</td>
<td>1,011</td>
<td>1,041 ***</td>
<td>1,011</td>
<td>0,993</td>
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<td><strong>Positions</strong></td>
<td>0,901</td>
<td>0,920</td>
<td>1,103</td>
<td>1,079</td>
<td>1,000</td>
<td>1,007</td>
<td>1,043</td>
<td>0,862</td>
<td>0,807 t</td>
<td>0,968</td>
<td>0,744 *</td>
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<td><strong>Strong scientific commitment</strong></td>
<td>1,081</td>
<td>2,925</td>
<td>1,197</td>
<td>0,857</td>
<td>0,753</td>
<td>0,710</td>
<td>1,236</td>
<td>0,211 t</td>
<td>0,350 *</td>
<td>1,859</td>
<td>3,128 *</td>
</tr>
</tbody>
</table>

**p** < 0.1, **p** < 0.05, **p** < 0.001, **p** < 0.0001
### Results: Prescribing pattern and patient-panel composition

#### Prescribing characteristics

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<tbody>
<tr>
<td>Prescribing intensity</td>
<td>0.947</td>
<td>1.099</td>
<td>1.048</td>
<td>0.978</td>
<td>0.995</td>
<td>1.085 **</td>
<td>1.017</td>
<td>1.013</td>
<td>0.99</td>
<td>1.024</td>
<td>1.013</td>
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<tr>
<td>Portfolio width</td>
<td>1.247</td>
<td>1.386</td>
<td>1.282</td>
<td>1.125</td>
<td>1.188</td>
<td>1.211</td>
<td>1.178</td>
<td>1.231</td>
<td>1.212</td>
<td>1.342</td>
<td>1.254</td>
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<tr>
<td>Insulin ration</td>
<td>1.008</td>
<td>0.963 **</td>
<td>0.985 **</td>
<td>0.979</td>
<td>0.974</td>
<td>0.973</td>
<td>0.984</td>
<td>0.971</td>
<td>0.982</td>
<td>1.011</td>
<td>0.962 ***</td>
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<tr>
<td>Old A10B ratio</td>
<td>1.028</td>
<td>0.952</td>
<td>1.005</td>
<td>0.995</td>
<td>0.945 *</td>
<td>1.015</td>
<td>0.963 ¤</td>
<td>0.958</td>
<td>0.977</td>
<td>1.015</td>
<td>0.917 *</td>
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#### Patient characteristics

<table>
<thead>
<tr>
<th></th>
<th>Age</th>
<th>Gender</th>
<th>Income</th>
<th>Health status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>1.045</td>
<td>0.930 ¤</td>
<td>0.987</td>
<td>1.015</td>
</tr>
<tr>
<td>Gender</td>
<td>1.006</td>
<td>1.043</td>
<td>0.989</td>
<td>1.005</td>
</tr>
<tr>
<td>Income</td>
<td>1.000</td>
<td>1.000</td>
<td>1.000</td>
<td>1.000</td>
</tr>
<tr>
<td>Health status</td>
<td>1.010 *</td>
<td>0.991</td>
<td>1.001</td>
<td>1.001</td>
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</table>

* p<0.05  ** p<0.001  *** p<0.0001
Results: Practice characteristics

<table>
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<th>Practice characteristics</th>
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<th>Byetta</th>
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<th>Velmetia</th>
<th>Victoza</th>
<th>Xelevia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of patients</td>
<td>1,001</td>
<td>1,001</td>
<td>0,999</td>
<td>1,003</td>
<td>1,000</td>
<td>1,001</td>
<td>1,000</td>
<td>1,002</td>
<td>1,001</td>
<td>1,000</td>
<td>0,999</td>
</tr>
<tr>
<td>Number of referring GPs</td>
<td>1,001</td>
<td>1,006</td>
<td>1,009</td>
<td>0,990</td>
<td>0,999</td>
<td>1,006</td>
<td>1,007</td>
<td>1,001</td>
<td>1,007</td>
<td>0,994</td>
<td>1,008</td>
</tr>
<tr>
<td>Consultations per patient</td>
<td>2,537 **</td>
<td>0,593</td>
<td>1,758 Ɨ</td>
<td>2,223 **</td>
<td>1,227</td>
<td>0,761</td>
<td>1,477</td>
<td>1,225</td>
<td>1,084</td>
<td>1,228</td>
<td>1,500</td>
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<tr>
<td>Proportion of loyal patients</td>
<td>0,994</td>
<td>0,988</td>
<td>0,982 ***</td>
<td>1,001</td>
<td>1,000</td>
<td>0,988 **</td>
<td>1,001</td>
<td>1,003</td>
<td>0,998</td>
<td>1,004</td>
<td>1,006</td>
</tr>
<tr>
<td>Practice location</td>
<td>0,947</td>
<td>0,636 *</td>
<td>1,068</td>
<td>0,935</td>
<td>0,987</td>
<td>1,046</td>
<td>1,023</td>
<td>1,076</td>
<td>0,971</td>
<td>0,922</td>
<td>1,029</td>
</tr>
<tr>
<td>Practice size</td>
<td>1,311 *</td>
<td>1,054</td>
<td>0,963</td>
<td>0,886</td>
<td>0,856</td>
<td>1,142</td>
<td>0,978</td>
<td>1,011</td>
<td>1,156</td>
<td>0,936</td>
<td>0,985</td>
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<td>Number of workplaces</td>
<td>1,133</td>
<td>0,686</td>
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<td>1,004</td>
<td>1,092</td>
<td>1,025</td>
<td>1,121</td>
<td>0,893</td>
<td>1,138</td>
<td>0,883</td>
<td>1,112</td>
</tr>
</tbody>
</table>

\* p<0.05  \** p<0.001  \*** p<0.0001
Conclusions I.

Three key determinants of new drug diffusion:

1. Portfolio width – the wider, the quicker the adoption
   – Bourke & Roper (2012)
   – Number of patients vs. Number of prescriptions

2. Insulin ratio – the lower, the quicker the adoption
   – Physicians’ convictions as to the most appropriate therapy
   – Many patients with long disease history
   – Patients at severe stages of the disease
   – Low-income patients

3. High adoption ratio of geographically close colleagues
Important role of two categories of factors: contagion measures and prescribing characteristics.

To rollout new drugs successfully, practice location and prescription data may be sufficient to identify target physicians, distribute marketing efforts, and allocate healthcare budgets.

The likelihood of adoption is not influenced by: behavior of former classmates, behavior of scientific collaborators, position, strong scientific commitment (key opinion leadership), number of specialties, number of publications, institution type.

Explanation for the insignificance of variables: high number and variety of variables, routine adoption instead of first-time adoption.
Limitations

• Incomplete prescription data:
  – Physicians’ prescribing behaviors are monitored through the reported prescription data by GPs with whom physicians share patient care.
  – No information on the physicians’ experimentation with the new drugs.

• The marketing efforts of pharmaceutical companies targeted at physicians are not accounted for.

• The contagion measure based on geographic proximity captures interpersonal effects indirectly.

• Conclusions based on only one therapeutic class (and one country) cannot be generalized.
THANK YOU FOR THE ATTENTION!

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