Direct & spillover effects of provider vaccination facilitation

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Immunization programs and take-up

- (Childhood) Immunization programs are among the most effective preventative public health measures.

- Practice styles vary across providers

- Network effects in health investment
Immunization programs and take-up

- (Childhood) Immunization programs are among the most effective preventative public health measures.

- Practice styles vary across providers

- Network effects in health investment

We ask two questions:
1. Do providers vary in their propensity to facilitate vaccinations?
2. Do provider propensities matter for patients?
We find meaningful variation in PVF and that PVF affects vaccine take-up

1. Meaningful variation in PVF
   - We estimate a model of vaccine compliance with family and provider contributions
   - A 1 standard deviation increase in PVF increases compliance by 1.7 percentage points

2. Impacts of PVF on Vaccine take-up in adolescence
   - Direct effect of PVF on HPV vaccination take-up in adolescence
   - Mitigating effect on the impact of an unsubstantiated documentary
   - Spillovers of high PVF providers to cousins of patients
From Danish registry data we construct two samples:

1. Danish administrative registry data:
   - Family links, patient-provider links, health insurance claims data

2. We construct two primary samples:
   - All children born 1997-2013 observed throughout their first 6 years of life:
     - N= 1.083Mn
     - Eligible for the early part of the childhood vaccination program
     - Use this sample to estimate PVF
   
   - All children born 1997-2007 observed +/- 2 years around their 12th Birthday
     - N=346,366
     - All are eligible for the late part of the program
     - Use this sample to estimate impact of PVF

   - All individuals are linked to their PCP
     - Practice level
     - in 2019 roughly 50% were single physician-practices
     - app. unique 3700 practices over time
We construct a metric for vaccine compliance with the recommendations

Vaccination schedule in DK:
- Early part: 0-5 years
  - *Di-Ki-Te-Pol-Hib*
  - MMR (+booster)
- Later part: 12 years
  - HPV
  - MMR booster
- Administered at the PCP

\[
Y_{iq} = \frac{\#\text{Vaccines taken}_{iq}}{\#\text{Vaccines rec.}_{iq}}
\]
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\[ Y_{iq} = \frac{\text{#Vaccines taken}_{iq}}{\text{#Vaccines rec.}_{iq}} \]
We model PVF linearly

- **Provider Vaccination Facilitation:**
  - Two-way fixed effects:
  - Model of vaccine compliance:
    - \( Y_{iq} = \alpha_{m(i)} + \gamma_{j(i,q)} + \delta_{q(i)} + X_i + \varepsilon_{iq} \)
    - where \( Y_{iq} \) is compliance with vaccination program
  - Simplifying assumptions:
    - additivity and separability of \( \gamma_{j(i,q)} \) and \( \alpha_{m(i)} \)
    - No sorting on individual specific gains: \( E[\gamma_{j(i,q)}\varepsilon_{iq}|\alpha_{m(i)},\delta_{q(i)},X_i] = 0 \)
We correct for measurement error and assess validity

1. **Measurement error: Limited mobility bias**
   - Split sample correction (Goldsmith & Steiger 2017, Drenik et al 2023):
     - Randomly split data into two groups
     - Estimate FE's on both samples separately
     - Predict FE's from sample 1 with FE's from sample 2

2. **Validity**: (in the paper)
   - Restrict ID'ing shifts to specific groups and/or separations
     - Residential relocators, practice closures, only boys, only girls, post 2007 cohorts
   - Match quality
     - Models including match effect yield identical results and match effects quantitatively small
   - Dynamic Sorting
     - High degree of mean reversion when switching provider (app. 90%)
     - When switching provider and aging in to new requirement, upcoming change in PVF predicts change in take-up (Chetty et al 2014)
Shrinkage and the distribution of PVF

\[ \sigma_{\gamma_j} = 1.7 \text{pp} \]
We ask two primary questions

1. Do providers vary in their propensity to facilitate vaccinations?
2. Do provider propensities matter for patients?
Higher PVF leads to higher HPV vaccine take-up

<table>
<thead>
<tr>
<th>12 months after HPV eligibility</th>
<th>Provider vaccination propensity</th>
<th>Mean childhood vaccination</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1.074*** (0.131)</td>
<td>0.314*** (0.009)</td>
</tr>
<tr>
<td></td>
<td>1.067*** (0.130)</td>
<td>0.311*** (0.009)</td>
</tr>
<tr>
<td></td>
<td>1.020*** (0.125)</td>
<td>0.316*** (0.009)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Observations</th>
<th>346,493</th>
<th>346,493</th>
<th>346,493</th>
</tr>
</thead>
<tbody>
<tr>
<td>R-squared</td>
<td>0.024</td>
<td>0.025</td>
<td>0.175</td>
</tr>
<tr>
<td>Mean outcome variable</td>
<td>0.704</td>
<td>0.704</td>
<td>0.704</td>
</tr>
<tr>
<td>F-stat</td>
<td>176.3</td>
<td>176</td>
<td>-</td>
</tr>
<tr>
<td>Municipality FE</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Birthyear x birthmonth</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Mother controls</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Father controls</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
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</tbody>
</table>
PVF mitigates impact of a (unsubstantiated) critical documentary

### 12 Month HPV vaccination

<table>
<thead>
<tr>
<th>Quartile of PVP x Born 2003</th>
<th>Q2xBorn2003</th>
<th>0.024</th>
<th>(0.017)</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>Q3xBorn2003</td>
<td>0.053***</td>
<td>(0.015)</td>
</tr>
<tr>
<td></td>
<td>Q4xBorn2003</td>
<td>0.050***</td>
<td>(0.014)</td>
</tr>
</tbody>
</table>

| PVP x Born 2003 | 1.934*** | (0.708) |

<table>
<thead>
<tr>
<th>Observations</th>
<th>107,780</th>
<th>107,780</th>
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</thead>
<tbody>
<tr>
<td>R-squared</td>
<td>0.652</td>
<td>0.648</td>
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<tr>
<td>Municipality FE</td>
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<td>Yes</td>
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<tr>
<td>Mother controls</td>
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<td>Yes</td>
</tr>
<tr>
<td>Father controls</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Mean outcome variable</td>
<td>0.583</td>
<td>0.583</td>
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<tr>
<td>2SLS</td>
<td>No</td>
<td>Yes</td>
</tr>
</tbody>
</table>
PVF affects patients network

<table>
<thead>
<tr>
<th>Cousins</th>
<th>HPV 12</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(5)</td>
</tr>
<tr>
<td>Own provider vaccination propensity</td>
<td>1.031***</td>
</tr>
<tr>
<td></td>
<td>(0.184)</td>
</tr>
<tr>
<td>Older cousin's PVP</td>
<td>0.302**</td>
</tr>
<tr>
<td></td>
<td>(0.115)</td>
</tr>
</tbody>
</table>

Observations: 107,695
Mean outcome variable: 0.671
F-stat own PVF: 157.2
F-stat Cousin PVF: 954.1

R-squared: 0.018
We find meaningful variation in PVF and that PVF affects vaccine take-up

1. **Meaningful variation in PVF**
   - A 1 standard deviation increase in PVF increases compliance by 1.7 percentage points
   - High PVF-providers are more likely to comply with child-well-visits, other types of preventative care and their patients have fewer ACSCs
   - The vaccine status of relatives of providers correlates positively with PVF

2. **Impacts of PVF on Vaccine take-up in adolescence**
   - Direct effect of PVF on HPV vaccination take-up in adolescence
   - Mitigating effect on the impact of an unsubstantiated documentary
   - Spillovers of high PVF providers to cousins of patients