Corporate Income Taxation and Firm Efficiency

Evidence from a large panel of European firms

Joanna Tyrowicz (IAAEU, GRAPE, UW and IZA)
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Karsten Staehr (TTU and Eestipank)

NBP Summer Workshop, 2019
Motivation

- Theory: taxes are (almost) neutral
  - if $Q = \arg\max \Pi$ then $\forall \tau$ it holds that $Q = \arg\max (1 - \tau)\Pi$
  - tax shield (financing cost and structure)
  - taxes on $K$ and $L$ could be affecting optimal $K/L$

- Reality: More efficient firms $\rightarrow$ profits $\uparrow$ $\rightarrow$ corr($\pi$, tax) $> 0$
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- **Theory:** taxes are (almost) neutral
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- **Reality:** More efficient firms \( \rightarrow \) profits \( \uparrow \) \( \rightarrow \) \( \text{corr}(\pi, \text{tax}) > 0 \)

**Question**

Are CI taxes neutral for firm efficiency?

- Taxes may be a cost \( \rightarrow \) reduce capital accumulation & investment
- Taxes may drive away from efficient technologies
Motivating example

Technology 1: immediate gratification

- Investment easily divisible
- Short cycle from investment to revenue
- High liquidity
Motivating example

Technology 1: immediate gratification

- Investment easily divisible
- Short cycle from investment to revenue
- High liquidity

Technology 2: suffering through the dungeons of depreciation

- Indivisible and large investments
- Long cycle from investment to revenue
- Low liquidity
Distortions to inter-temporal decisions (investment $\rightarrow$ capital)
- Modigliani & Miller (1965), Auerbach (1979), Fazzari et al (1988) ...
- Giroud and Rauh (2019)
Distortions to inter-temporal decisions (investment → capital)

Exploit tax reforms / discontinuities for exogeneity
• Distortions to inter-temporal decisions (investment $\rightarrow$ capital)
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• Exploit tax reforms / discontinuities for exogeneity
• (Accounting) Literature on book-tax conformity and tax audits
Distortions to inter-temporal decisions (investment $\rightarrow$ capital)

Exploit tax reforms / discontinuities for exogeneity

(Accounting) Literature on book-tax conformity and tax audits

Contribution
- Instead of reforms: “business as usual” identification
- Instead of inter-temporal decision: value added (efficiency)
- Generally accessible data
Identification strategy

\[ Y_{i,t} = A(tax_{i,t}, \cdot)K_{i,t}^{\beta_k} + L_{i,t}^{\beta_l} \] (1)

OLS estimation of \( A \) biased \( \rightarrow \) instrument
Identification strategy

\[ Y_{i,t} = A(tax_{i,t}, \cdot) K_{i,t}^{\beta_k^s} + L_{i,t}^{\beta_i^s} \]  

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OLS estimation of \( A \) biased \( \rightarrow \) instrument

1. Measure technology specific effective tax rate \( \rightarrow \) deviations
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(1)

OLS estimation of $A$ biased $\rightarrow$ instrument

1. Measure technology specific effective tax rate $\rightarrow$ deviations
   - average across all countries LYO (=all but “mine”)
   - deviation from the national effective tax rate
   - in a given sector (NACE 4 digit)
   - standardized (in SDs)

2. Firm FE, so only variation over time (country and sector specific)
Identification strategy

\[ Y_{i,t} = \mathcal{A}(tax_{i,t}, \cdot)K_{i,t}^{\beta_k} + L_{i,t}^{\beta_l} \] (1)

OLS estimation of \( \mathcal{A} \) biased \( \rightarrow \) instrument

1. Measure technology specific effective tax rate \( \rightarrow \) deviations
2. Firm FE, so only variation over time (country and sector specific)

\[ IV_{c,s,t} = \frac{(ETR_{s,t} - \sum_{i \notin (c)} ETR_{s,t})}{\sqrt{\frac{1}{\sum_{i \notin (c)} \sum_{i \notin (c)} ETR_{s,t}}}} \]

3. Use this \( IV_{c,s,t} \) in estimation
Identification strategy

\[ Y_{i,t} = A(tax_{i,t}, \cdot)K_{i,t}^{\beta_k^s} + L_{i,t}^{\beta_l^s} \]  

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OLS estimation of \( A \) biased \( \rightarrow \) instrument

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\[
\begin{align*}
\log VA_{i,t} &= \beta_k^s \log k_{i,t} + \beta_l^s \log l_{i,t} + \alpha tax_{i,t} + u_t + u_i + \epsilon_{i,t} \\
tax_{i,t} &= \delta \cdot IV_{c,s,t} + \eta_t + \epsilon_{i,t}
\end{align*}
\]
Data
Uniquely vast data

8 waves of Amadeus data

- 12 mio firms, 69 mio fim-years over nearly 3 decades from 44 countries
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- Public (listed) and private (even very small) firms
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- Balance sheets and P/L statements (+ firm characteristics)

- ≈ 50% in market services

Kalemli-Ozcan et al (2015): standard for cleaning one wave of the data

We combine many waves: fill in many missings (4% vs ≈ 40%)

In addition: we also impute

Flexibility in measurement of taxation

Firm history + country tax rules → carry forward eligibility
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- Flexibility in measurement of taxation
- Firm history + country tax rules \( \rightarrow \) carry forward eligibility
Some stylized facts

Table 1: Sources of variation in taxation measures

<table>
<thead>
<tr>
<th>Variable</th>
<th>Firm</th>
<th>Country</th>
<th>Sector</th>
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<th>Country</th>
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</tr>
</thead>
<tbody>
<tr>
<td>BTD</td>
<td>17.8%</td>
<td>0.1%</td>
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<td>15.5%</td>
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</tr>
<tr>
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Positive correlation is robust: \( corr(\tau, \pi) > 0 \)

Table 2: Elasticity of output with respect to taxation (FE OLS)

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<tr>
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<th>( \text{Full} ) T</th>
<th>Q1 T</th>
<th>Q2 T</th>
<th>Q3 T</th>
<th>Q4 T</th>
<th>P25 T</th>
<th>P50 T</th>
<th>P75 T</th>
</tr>
</thead>
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<tr>
<td>tax</td>
<td>0.133 (0.000)</td>
<td>0.107 (0.000)</td>
<td>0.115 (0.000)</td>
<td>0.135 (0.000)</td>
<td>0.167 (0.000)</td>
<td>0.119 (0.000)</td>
<td>0.125 (0.000)</td>
<td>0.147 (0.000)</td>
</tr>
<tr>
<td>k</td>
<td>0.255 (0.000)</td>
<td>0.231 (0.000)</td>
<td>0.254 (0.000)</td>
<td>0.273 (0.000)</td>
<td>0.274 (0.000)</td>
<td>0.245 (0.001)</td>
<td>0.263 (0.000)</td>
<td>0.276 (0.000)</td>
</tr>
<tr>
<td>l</td>
<td>0.539 (0.000)</td>
<td>0.602 (0.000)</td>
<td>0.570 (0.000)</td>
<td>0.524 (0.000)</td>
<td>0.474 (0.000)</td>
<td>0.577 (0.001)</td>
<td>0.549 (0.000)</td>
<td>0.504 (0.000)</td>
</tr>
<tr>
<td>( R^2 )</td>
<td>0.851</td>
<td>0.879</td>
<td>0.872</td>
<td>0.852</td>
<td>0.812</td>
<td>0.873</td>
<td>0.865</td>
<td>0.841</td>
</tr>
<tr>
<td># i</td>
<td>2,625,365</td>
<td>814,839</td>
<td>529,788</td>
<td>634,856</td>
<td>645,882</td>
<td>313,784</td>
<td>509,907</td>
<td>501,467</td>
</tr>
</tbody>
</table>

\( N (1) \approx 10.2 \text{ mln} \)

\( N (2) – (5) \approx 2.2 \text{mln} \)

\( N (6) – (9) \approx 2 \text{ mln} \)
Positive correlation is robust: $\text{corr}(\tau, \pi) > 0$

Table 3: Elasticity of production with respect to taxation (FE OLS)

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<th>Q3 VA</th>
<th>Q4 VA</th>
<th>P25 VA</th>
<th>P50 VA</th>
<th>P75 VA</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>(2a)</td>
<td>(3a)</td>
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<td>(5a)</td>
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<td>(8a)</td>
</tr>
<tr>
<td>tax</td>
<td>0.205***</td>
<td>0.146***</td>
<td>0.123***</td>
<td>0.108***</td>
<td>0.167***</td>
<td>0.132***</td>
<td>0.117***</td>
</tr>
<tr>
<td></td>
<td>(0.000)</td>
<td>(0.000)</td>
<td>(0.000)</td>
<td>(0.000)</td>
<td>(0.000)</td>
<td>(0.000)</td>
<td>(0.000)</td>
</tr>
<tr>
<td>k</td>
<td>0.286***</td>
<td>0.249***</td>
<td>0.232***</td>
<td>0.231***</td>
<td>0.261***</td>
<td>0.240***</td>
<td>0.228***</td>
</tr>
<tr>
<td></td>
<td>(0.000)</td>
<td>(0.000)</td>
<td>(0.000)</td>
<td>(0.000)</td>
<td>(0.000)</td>
<td>(0.000)</td>
<td>(0.000)</td>
</tr>
<tr>
<td>l</td>
<td>0.483***</td>
<td>0.544***</td>
<td>0.572***</td>
<td>0.564***</td>
<td>0.518***</td>
<td>0.562***</td>
<td>0.573***</td>
</tr>
<tr>
<td></td>
<td>(0.000)</td>
<td>(0.000)</td>
<td>(0.000)</td>
<td>(0.000)</td>
<td>(0.000)</td>
<td>(0.000)</td>
<td>(0.000)</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.861</td>
<td>0.865</td>
<td>0.862</td>
<td>0.828</td>
<td>0.863</td>
<td>0.865</td>
<td>0.853</td>
</tr>
<tr>
<td># N</td>
<td>1,927,477</td>
<td>2,491,774</td>
<td>2,867,614</td>
<td>2,876,870</td>
<td>1,820,682</td>
<td>2,167,947</td>
<td>2,382,326</td>
</tr>
<tr>
<td># i</td>
<td>660,251</td>
<td>652,751</td>
<td>656,461</td>
<td>655,902</td>
<td>526,093</td>
<td>524,682</td>
<td>523,986</td>
</tr>
</tbody>
</table>
Results
Results

\[ \log VA_{i,t} = \beta_k \log k_{i,t} + \beta_l \log l_{i,t} + \alpha(tax_{i,t}) + u_t + u_i + \epsilon_{i,t} \]

\[ tax_{i,t} = \delta \cdot IV_{c,s,t} + \eta_t + \epsilon_{i,t} \]
Results

\[ \log \text{VA}_{i,t} = \beta_k^s \log k_{i,t} + \beta_l^s \log l_{i,t} + \alpha(\hat{\text{tax}}_{i,t}) + u_t + u_i + \epsilon_{i,t} \]
\[ \text{tax}_{i,t} = \delta \cdot \text{IV}_{c,s,t} + \eta_t + \epsilon_{i,t} \]

**Table 4:** OLS vs IV estimation of \( \alpha \)

<table>
<thead>
<tr>
<th></th>
<th>OLS Firms in ‘trusted’ sectors</th>
<th>IV Firms in ‘trusted’ sectors ineligible to CF</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>FE FE FD</td>
<td>FE FD MI FE MI FD</td>
</tr>
<tr>
<td>Controlling for inputs</td>
<td>0.133 -0.043 -0.035</td>
<td>-0.056 -0.032 -0.053 -0.039</td>
</tr>
<tr>
<td></td>
<td>(0.000) (0.004) (0.008)</td>
<td>(0.005) (0.008) (0.006) (0.011)</td>
</tr>
</tbody>
</table>
Results

\[
\log VA_{i,t} = \beta_k \log k_{i,t} + \beta_l \log l_{i,t} + \alpha(tax_{i,t}) + u_t + u_i + \epsilon_{i,t}
\]

\[
tax_{i,t} = \delta \cdot IV_{c,s,t} + \eta_t + \epsilon_{i,t}
\]

Table 4: OLS vs IV estimation of \( \alpha \)

<table>
<thead>
<tr>
<th></th>
<th>OLS</th>
<th>IV</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Firms in ‘trusted’ sectors</td>
<td>Firms in ‘trusted’ sectors ineligible to CF</td>
</tr>
<tr>
<td></td>
<td>FE</td>
<td>FE</td>
</tr>
<tr>
<td>Controlling for inputs</td>
<td>0.133 (0.000)</td>
<td>-0.043 (0.004)</td>
</tr>
<tr>
<td>No inputs</td>
<td>0.26 (0.000)</td>
<td>0.29 (0.005)</td>
</tr>
</tbody>
</table>
## Results – robustness

### Table 5: Elasticity of TFP with respect to taxation (IV)

<table>
<thead>
<tr>
<th></th>
<th>Sector specific intercept</th>
<th>Sector specific intercept and slopes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>All No CF</td>
<td>All No CF</td>
</tr>
<tr>
<td><strong>Second stage</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>tax</strong></td>
<td>-0.043</td>
<td>-0.056</td>
</tr>
<tr>
<td></td>
<td>(0.004)</td>
<td>(0.005)</td>
</tr>
<tr>
<td><strong>k</strong></td>
<td>0.35</td>
<td>0.37</td>
</tr>
<tr>
<td></td>
<td>(0.002)</td>
<td>(0.003)</td>
</tr>
<tr>
<td><strong>l</strong></td>
<td>0.56</td>
<td>0.54</td>
</tr>
<tr>
<td></td>
<td>(0.001)</td>
<td>(0.001)</td>
</tr>
<tr>
<td><strong>R²</strong></td>
<td>0.75</td>
<td>0.71</td>
</tr>
<tr>
<td><strong>First stage</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>IV</strong></td>
<td>0.014</td>
<td>.015</td>
</tr>
<tr>
<td></td>
<td>(0.000)</td>
<td>(0.000)</td>
</tr>
<tr>
<td><strong>R²</strong></td>
<td>0.12</td>
<td>0.13</td>
</tr>
</tbody>
</table>

Note: FE and FD indicate fixed effects and first differences, respectively.
Results – a lot of heterogeneity

[Bar chart showing a wide range of values for different countries, indicating significant variability.]
Results – but this heterogeneity is not on skill
Results – and is quite specific to industries

A: Agriculture
C: Mining
DA: Manufacture of food products
DB: Manufacture of textiles
DC: Manufacture of leather
DD: Manufacture of wood
DE: Manufacture of paper
DF: Manufacture of refined petroleum products
DG: Manufacture of chemicals
DH: Manufacture of plastic products
DI: Manufacture of other non-metallic products
DJ: Manufacture of basic metals
DK: Manufacture of machinery and equipment n.e.c.
DL: Manufacture of electrical and optical equipment
DM: Manufacture of transport equipment
DN: Manufacturing n.e.c.
E: Electricity gas and water supply
F: Construction
G: Wholesale and retail trade
H: Hotels and restaurants
I: Transport storage and communication
Let’s pretend that we take those results seriously
Implications

Welfare cost of taxing the capital goes beyond accumulation or K/L

- Model with the choice of technology
Implications

Welfare cost of taxing the capital goes beyond accumulation or K/L

- Model with the choice of technology
- Myopia in technology choice by firms
Implications

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- Model with the choice of technology
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- Credit constraints vs “type” of technology
Implications

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- Where from the cross-country heterogeneity? What does it imply?
Implications

Welfare cost of taxing the capital goes beyond accumulation or K/L

- Model with the choice of technology
- Myopia in technology choice by firms
- Credit constraints vs “type” of technology
- Another friction in “directed” search

- Where from the cross-country heterogeneity? What does it imply?
- Can we build intuitions on this unobserved choice from the data?
Summary

- Still work in progress!
Summary

- Still work in progress!
- We test neutrality of taxation with large new panel and a new instrument
- on average 10% more CIT to be paid $\rightarrow$ 4% lower VA

- Where next (empirically):
  - try out this IV vs Bartik instruments vs "traditional" causal identification
  - selection into CF?
Summary

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- We test neutrality of taxation with large new panel and a new instrument
  - on average 10% more CIT to be paid $\rightarrow$ 4% lower VA
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Summary

- **Still work in progress!**
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- very heterogeneous: across industries and countries $\rightarrow$ WHY?
- Where next (empirically):
  - try out this IV vs Bartik instruments vs “traditional” causal identification
  - selection into CF?
Thank you and
I am happy to take questions!

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f: grape.org
e: j.tyrowicz@grape.org.pl