Did the depression change the structure of production in Greece?
Before-and-after snapshots of sectoral production functions

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Philosophical matters

- Do depressions have structural effects on production?

- Do they change the way we produce things? The way we do things?
Before-and-After view

This?

Greek Production Before-and-After the depression (July 2022)
Before-and-After view

Or even this?

BEFORE...

AFTER...

We will find out, one sector at a time
Before-and-After view

• Compare samples before and after the crisis and the depression
  • Year 2008 against year 2019

• At 3-digit sectoral level
  (NACE rev.2 classification)

• We plan to examine 43 such sectors
  (not more, due to data limitations)
Samples & Data

• **Main data sources:**
  - ICAP dbase of Balance Sheet data
  - Eurostat SBS for mean wages

• **Industrial, commerce, services**
  - Cross-sectional unbalanced samples
  - Sizes no smaller than 50, no larger than 1000

• 43 3-digit sectors, and overall ~20,000 observations
Samples & Data - Issues

• **Main data limitation 1:** “personal” companies without published balance sheets are missing

• **Main data limitation 2:** labor quantity not always available
  - Conservative imputation (interpolation) for labor headcount to improve sample sizes

• Labor cost based on 3-digit or 2-digit averages (affects value-added)
Regression & Variables

- **Production function**: Translog
- **Dependent Variable**: Value-added
- **Inputs**: Labor (headcount) and Capital
  
  ...with a twist:

  *Two* capital inputs,

  - **Fixed Assets** *(Land, Buildings, Machinery, Vehicles)*
  - **Current Assets** *(Inventory, Receivables)*

  ...to assess their possibly distinct relation with value-added (and/or different response to the depression)
Regression & Variables

• Log-variables (Dep-var + inputs) are centered
  • Less/no multicollinearity
  • Reasonable center-of-expansion (geometric mean)
  • No constant term

• Controls (not in logs nor centered)
  • Firm age (integer)
  • Urban Center Location (Athens/Thessaloniki or not)
  • Export/Import orientation or not
  • Publicly traded or not
  • Long-term funding index (Balance-Sheet-ratio)
Model

- **Two-tier stochastic frontier** production model (**2TSF**)
  - It measures **inefficiency and management effects on production**


\[
Q = F(x) \cdot e^v \cdot e^w \cdot e^{-u}
\]

Max **non-managed production function**

**2TSF composed error term**

\[
\mathcal{E} = v + w - u \quad w, u \geq 0
\]
Estimation

• **Two-tier** stochastic frontier model

\[ \varepsilon = v + w - u \]

\[ v \sim N(0, \sigma_v), \quad w \sim \text{Exp}(\sigma_w), \quad u \sim \text{Exp}(\sigma_u) \]

• **Maximum Likelihood**

• **OLS** as an Intro and a contrast

• **Quantile regression** to get finer detail on output elasticities
Handling Input Endogeneity

• Beginning-of-period capital inputs

• Copula attached to the likelihood to account for possible labor endogeneity

Main research outputs

- BEFORE & AFTER the depression (sectoral):
  - Output elasticities of inputs
  - Separate effects of Fixed/Current capital
  - Management effects on output
  - Efficiency/Inefficiency

\[ \times 43 = \textbf{Intersectoral comparisons and macro-level results} \]

- Overall picture / policy implications
Pilot Empirical Application

• 3-digit sector **141**: Production of non-fur clothing

<table>
<thead>
<tr>
<th>Year</th>
<th>2008</th>
<th>2019</th>
</tr>
</thead>
<tbody>
<tr>
<td>ICAP data base size</td>
<td>353</td>
<td>248</td>
</tr>
<tr>
<td>Sample size</td>
<td>120</td>
<td>139</td>
</tr>
<tr>
<td># recurring firms</td>
<td>36</td>
<td></td>
</tr>
<tr>
<td># obs with imputed headcount</td>
<td>17</td>
<td>3</td>
</tr>
<tr>
<td># obs with labor cost capped at total expenses</td>
<td>1</td>
<td>3</td>
</tr>
</tbody>
</table>

Wage cost base

<table>
<thead>
<tr>
<th></th>
<th>Eurostat SBS 141-sector average differentiated for Headcount &lt;10 / &gt;=10</th>
<th>Eurostat SBS 141-sector average differentiated for Headcount &lt;10 / &gt;=10</th>
</tr>
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<tr>
<td></td>
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</table>
“141” Production of non-fur clothing

Sample Composition: Contingency table – relative frequencies for firm size

<table>
<thead>
<tr>
<th>Headcount</th>
<th>Capital/Labor ratio</th>
<th>2008</th>
<th>2019</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$n = 120$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;10</td>
<td></td>
<td>0.03</td>
<td>0.12</td>
</tr>
<tr>
<td>10-49</td>
<td></td>
<td>0.24</td>
<td>0.29</td>
</tr>
<tr>
<td>&gt;=50</td>
<td></td>
<td>0.08</td>
<td>0.09</td>
</tr>
<tr>
<td><strong>Σ</strong></td>
<td></td>
<td>0.34</td>
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<th>2019</th>
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<td></td>
<td>$n = 139$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;10</td>
<td></td>
<td>0.03</td>
<td>0.12</td>
</tr>
<tr>
<td>10-49</td>
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<td><strong>Σ</strong></td>
<td></td>
<td>0.34</td>
<td>0.49</td>
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2019 has more smaller companies (this may be the “IKE effect”)

Greek Production Before-and-After the depression (July 2022)
### "141": Production of non-fur clothing

**DESCRIPTIVE STATISTICS**

<table>
<thead>
<tr>
<th></th>
<th>2008</th>
<th>2019</th>
<th>%Δ</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Value-added</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(,000) mean</td>
<td>1456</td>
<td>795.2</td>
<td>-45.4%</td>
</tr>
<tr>
<td>(,000) median</td>
<td>664.7</td>
<td>330.4</td>
<td>-50.3%</td>
</tr>
<tr>
<td>(,000) sd</td>
<td>1981</td>
<td>1555</td>
<td></td>
</tr>
<tr>
<td><strong>Fixed Assets</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(,000) mean</td>
<td>1936</td>
<td>1756</td>
<td>-9.3%</td>
</tr>
<tr>
<td>(,000) median</td>
<td>452.2</td>
<td>321.3</td>
<td>-28.9%</td>
</tr>
<tr>
<td>(,000) sd</td>
<td>4716</td>
<td>5757</td>
<td></td>
</tr>
<tr>
<td><strong>Current Assets</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(,000) mean</td>
<td>4328</td>
<td>2777</td>
<td>-35.8%</td>
</tr>
<tr>
<td>(,000) median</td>
<td>1993</td>
<td>1495</td>
<td>-25.0%</td>
</tr>
<tr>
<td>(,000) sd</td>
<td>5446</td>
<td>4803</td>
<td></td>
</tr>
<tr>
<td><strong>Headcount</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>mean</td>
<td>44.9</td>
<td>34.7</td>
<td>-22.7%</td>
</tr>
<tr>
<td>median</td>
<td>20.5</td>
<td>18</td>
<td>-12.2%</td>
</tr>
<tr>
<td>sd</td>
<td>59.2</td>
<td>61.1</td>
<td></td>
</tr>
<tr>
<td><strong>Yearly wage cost &lt;10</strong></td>
<td>14,411 €</td>
<td>9,438 €</td>
<td>-34.5%</td>
</tr>
<tr>
<td><strong>Yearly wage cost &gt;=10</strong></td>
<td>22,679 €</td>
<td>14,595 €</td>
<td>-35.6%</td>
</tr>
</tbody>
</table>

Greek Production Before-and-After the depression (July 2022)
**“141”: Production of non-fur clothing**

<table>
<thead>
<tr>
<th>Elasticities (mean values)</th>
<th>2008</th>
<th>2019</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fixed Assets</td>
<td>0.048</td>
<td>-0.005</td>
</tr>
<tr>
<td>Current Assets</td>
<td>0.248</td>
<td>0.169</td>
</tr>
<tr>
<td>Labor (Headcount)</td>
<td>0.691</td>
<td>1.067</td>
</tr>
<tr>
<td>Firm Age (semi-elasticity)</td>
<td>-0.004</td>
<td>0.000</td>
</tr>
<tr>
<td>Urban Center (binary)</td>
<td>0.115</td>
<td>0.078</td>
</tr>
<tr>
<td>Long-Term funding (BS ratio)</td>
<td>-0.155</td>
<td>-0.116</td>
</tr>
</tbody>
</table>

**Latent Effects**

\[
\frac{\mathbb{E}(e^w)}{\mathbb{E}(e^{-u})} = \frac{\mathbb{E}(e^{w-u})}{\mathbb{E}(e^w)}
\]

<table>
<thead>
<tr>
<th>Latent Effects</th>
<th>2008</th>
<th>2019</th>
</tr>
</thead>
<tbody>
<tr>
<td>Management Factor</td>
<td>1.188</td>
<td>1.797</td>
</tr>
<tr>
<td>External Inefficiency (points away from the frontier)</td>
<td>0.211</td>
<td>0.210</td>
</tr>
<tr>
<td>Unmanaged Efficiency</td>
<td>0.789</td>
<td>0.790</td>
</tr>
<tr>
<td>Tug-of-War net effect</td>
<td>0.937</td>
<td>1.420</td>
</tr>
</tbody>
</table>
“141”: Production of non-fur clothing

- **Low** FIXED ASSETS output elasticity  
  *from* 0.048 *to* ~0.0  
  - Capacity does not explain value-added  
  - => Capacity is there => capital unemployment  
  - Any effect was eliminated **due to the depression**  
    (investments were not a business option)

- **Reduced** CURRENT ASSETS output elasticity  
  *from* 0.248 *to* 0.169  
  - Reduced Inventories and Customer Credit, and **more** insensitive to demand (hard costs and liquidity)  
  - ... a standard depression effect
“141”: Production of non-fur clothing

- Increased LABOR output elasticity from 0.691 to 1.067
  - Much cheaper labor (approx. -35%)
  - Used to manage demand
  - Effect of regulatory reform?

- Management and external inefficiency
  - The environment remained stable w.r.t. imposed inefficiency
  - ...BUT the management effect improved greatly: from 1.188 to 1.797
    - a benefit due to the depression

Greek Production Before-and-After the depression (July 2022)
“141”: Production of non-fur clothing

Quantile elasticities – FIXED ASSETS

2008

- Fixed Assets elasticity static across the conditional distribution of value-added in both time periods, except

- the uptick in the more productive firms in 2019, indicating gearing-up

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Quantile elasticities – CURRENT ASSETS

2008

2019

Structural change – dampened effects in 2019 compared to 2008, as firm output/efficiency increases

Greek Production Before-and-After the depression (July 2022)
“141”: Production of non-fur clothing

Quantile elasticities – LABOR

Same trend (monotonic reduction) moving to larger/more efficient firms.

Greek Production Before-and-After the depression (July 2022)
Looking ahead – the 43 sectors

101 Processing and preserving of meat and production of meat products
103 Processing and preserving of fruit and vegetables
105 Manufacture of dairy products
107 Manufacture of bakery and farinaceous products
108 Manufacture of other food products
110 Manufacture of beverages
141 Manufacture of wearing apparel, except fur apparel
172 Manufacture of articles of paper and paperboard
181 Printing and service activities related to printing
222 Manufacture of plastic products
236 Manufacture of articles of concrete, cement and plaster
251 Manufacture of structural metal products
259 Manufacture of other fabricated metal products
310 Manufacture of furniture
Looking ahead – the 43 sectors

412 Construction of residential and non-residential buildings
421 Construction of roads and railways
432 Electrical, plumbing and other construction installation activities
451 Sale of motor vehicles
453 Sale of motor vehicle parts and accessories
461 Wholesale on a fee or contract basis
463 Wholesale of food, beverages and tobacco
464 Wholesale of household goods
465 Wholesale of information and communication equipment
466 Wholesale of other machinery, equipment and supplies
467 Other specialised wholesale
469 Non-specialised wholesale trade
471 Retail sale in non-specialised stores
475 Retail sale of other household equipment in specialised stores
477 Retail sale of other goods in specialised stores
494 Freight transport by road and removal services
Looking ahead – the 43 sectors

522 Support activities for transportation
551 Hotels and similar accommodation
561 Restaurants and mobile food service activities
581 Publishing of books, periodicals and other publishing activities
620 Computer programming, consultancy and related activities
642 Activities of holding companies
661 Activities auxiliary to financial services, except insurance and pension funding
682 Rental and operating of own or leased real estate
702 Management consultancy activities
711 Architectural and engineering activities and related technical consultancy
731 Advertising
791 Travel agency and tour operator activities
869 Other human health activities
Main research outputs reminder

- BEFORE & AFTER the depression (sectoral):
  - Output elasticities of inputs
  - Separate effects of Fixed/Current capital
  - Management effects on output
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× 43 = Intersectoral comparisons and macro-level results

- Overall picture / policy implications
CRETE2022, Greece, Tinos
July 2022

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THANK YOU!