Firm Size Distortions and the Productivity Distribution: Evidence from France

Luis Garicano (LSE, CEP, CEPR)
Claire Lelarge (INSEE)
John Van Reenen (LSE, CEP, NBER)

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Or…… “Lucas in France”
MOTIVATION

1. **Reallocation**: bigger share of economic activity to more productive/efficient firms. Important in understanding:
   - Aggregate productivity changes over time *within countries* (e.g. Bailey et al, 1992) & *within industries*
   - Trade with heterogeneous firms (e.g. Melitz, 2003)
   - Aggregate productivity *across countries* (Hsieh & Klenow, 2009; Bartelsman, Haltiwanger & Scarpetta, 2013)
MANAGEMENT QUALITY DISTRIBUTION ACROSS FIRMS WITHIN COUNTRIES (BLOOM & VAN REENEN DATA) TAIL OF VERY BADLY MANAGED FIRMS SMALLEST IN US

Firm-Level Management Scores (1=worst, 5=Best)
MOTIVATION

1. **Reallocation**: bigger share of economic activity to more productive/efficient firms. Important in understanding:
   - Aggregate productivity changes over time within countries (e.g. Bailey et al, 1992) & within industries
   - Trade with heterogeneous firms (e.g. Melitz, 2003)
   - Aggregate productivity across countries (Hsieh & Klenow, 2009; Bartelsman, Haltiwanger & Scarpetta, 2013)

2. **Labor market regulation**
   - How do we estimate the cost of labor regulations? Most Employment Protection Indices are crude & legally based
   - Our alternative: back out implicit regulatory “tax” using theory & data
     - Labor Reform is hot political issue in EU due to crisis
     - In France regulation increases for firms >50 workers
     - Affordable Care Act penalties for firms >50 workers who don’t offer health insurance, but not smaller firms
SUMMARY

• Focus on major labor regulations in GE setting:

• Method for estimating effects of size-related regulation
  – Extension of Lucas (1978) firm size in GE
  – Exploit discontinuity in size-distribution (“Broken power law”) & theory for structural estimation

• Findings:
  – Big distributional effects: workers & large firms lose; small firms gain
  – Welfare costs potentially large: ~1% GDP if real wages fully adjust to regulation; ~5% if real wages downwardly inflexible (US/France contrast?)
RAW DATA ON NUMBER OF FIRMS BY EACH SIZE CLASS (INTEGER NUMBER OF EMPLOYEES)

Exactly 49 employees
FIG 1: FIRM SIZE DISTRIBUTION: US DOESN’T HAVE A BREAK AT 49 WORKERS LIKE FRANCE
WHY THE BREAK AT 49 WORKERS?

• Sharp increase in regulation at 50 workers
  – Creation of “work council” (“comité d’entreprise”)
  – Firm has to offer union representation
  – Health & safety committee
  – Profit sharing scheme
  – Collective dismissal requires “social plan” to facilitate re-employment through training, job search, etc. Negotiated/monitored by unions & Labor Ministry

• These costs make firms reluctant to grow: an implicit tax on firm size (e.g. Bentolila & Bertola, 1990)
EXAMPLES OF RELATED PREVIOUS LITERATURE

• Lucas model applications

• Firm Size Distribution
  – Gibrat (1931); Axtell (2001); Ramsden & Kiss-Hapal (2000); Giovanni et al (2010); Hernandez-Perez et al (2006)

• Labor Market Regulation

• Productivity and Firm Size

• Discontinuities related to tax kinks & notches
  – Saez (2010); Chetty et al (2011); Kleven et al (2011); Kleven & Wassoum (2012)
1. Theory: “Lucas in France”

2. Empirical Implementation

3. Data

4. Results
   - Main findings
   - Robustness/Extensions
BASELINE THEORY

• One input, one sector a la Lucas (1978)

• Distribution of managerial ability ($\alpha$)

• **Ability:** how much an agent can raise a team’s output:
  – Manager with ability $\alpha$ and $n$ workers produces $y = \alpha f(n)$
  – $f'(n) > 0$, $f''(n) < 0$ from managerial span of control problem (e.g. $f(n) = n^\theta$, $\theta < 1$)
  – More able managers run bigger firms
INDIVIDUAL OPTIMIZATION

• Economy-wide wage, $w$

• Profits:

$$\pi(\alpha) = \max_n \begin{cases} \alpha f(n) - wn & \text{if } n \leq N \\ \alpha f(n) - w(N + \tau(n - N)) - F & \text{if } n > N \end{cases}$$

• Once employment exceeds $N=49$ regulation implies implicit taxes: variable cost, $\tau$ & fixed cost, $F$

• First order condition at each side of threshold:

$$\alpha f'(n^*) - \overline{\tau}w = 0, \quad \text{with} \quad \begin{cases} \overline{\tau} = 1 & \text{if } n \leq N \\ \overline{\tau} = \tau & \text{if } n > N \end{cases}$$
EQUILIBRIUM (1/3)

1. Wage level $w$
2. An allocation $n(\alpha)$: firm size ($n$) function of ability ($\alpha$)
3. A triple of cutoffs
   - $\{\alpha_{\text{MIN}}, \alpha_{\text{C}}, \alpha_{\text{U}}\}$
EQUILIBRIUM (2/3)

1. Labor supply = labor demand

2. No agent wishes to change occupation from manager to worker or to change from unconstrained to constrained

3. The choice of $n(\alpha)$ for each manager is optimal given their skills $\alpha$, taxes $\tau$, $k$ and wage $w$

   “Marginal Manager” at $\alpha_U$
EQUILIBRIUM (3/3)

• Firm size & productivity:

\[ n^*(\alpha) = 0 \quad \text{if } \alpha < \alpha_{\text{min}} \]

\[ n^*(\alpha) = f'^{-1}\left(\frac{w^*}{\alpha}\right) \quad \text{if } \alpha_{\text{min}} \leq \alpha \leq \alpha_c \]

\[ n^*(\alpha) = N \quad \text{if } \alpha_c \leq \alpha < \alpha_u \]

\[ n^*(\alpha) = f'^{-1}\left(\frac{\tau w^*}{\alpha}\right) \quad \text{if } \alpha \geq \alpha_u \]

Workers

‘Small Firms’

‘Constrained’

‘Unconstrained’
MANAGERIAL ABILITY DISTRIBUTION

• Following Lucas (1978) assume:
  – The managerial returns to scale function has a constant ‘elasticity’ form. We assume $f(n) = n^\theta$
  – A power law in firm size requires a power law in the ability distribution. Assume pdf of ability is:

\[
\phi(\alpha) = c_\alpha \cdot \alpha^{-\beta_\alpha}
\]
Notes: parameter values are $\beta_\alpha=1.6$, $\tau=1.01$, $n_u=60$
THEORY: SIZE AND PRODUCTIVITY (FIG. 3B)

Notes: parameter values are $\beta_\alpha=1.6, \tau=1.01, n_u=60$
THEORY: SIZE AND PRODUCTIVITY (FIG 3B)

Some productive firms Choose to remain small To avoid “tax”
LABOR REGULATION GENERATES ‘TOO MANY’ SMALL FIRMS FOR TWO REASONS

• Firms choosing to remain small to avoid the regulation

• Equilibrium wage lower as workers bear some of the incidence of tax
  – This encourages low managerial ability individuals to form firms instead of remaining workers
  – And smaller firms enjoy lower labor costs

• ‘Too many’ small firms in Europe?
  – Braguinsky, Branstetter & Regateiro (2011) on Portugal
OUTLINE

1. Theory: Lucas in France

2. Empirical Implementation

3. Data

4. Results
   - Main findings
   - Robustness/Extensions
EMPIRICAL IMPLEMENTATION

• Equilibrium Firm Size Distribution (pdf of $n^*$):

$$
\chi^*(n) = \begin{cases} 
(1-\theta)^{1-\beta} (\beta - 1)n^{-\beta} & \text{if } \frac{\theta}{1-\theta} \leq n < N \\
(1-\theta)^{1-\beta} (N^{1-\beta} - Tn_u^{1-\beta}) & \text{if } n = N \\
0 & \text{if } N < n < n_u \\
(1-\theta)^{1-\beta} (\beta - 1)Tn^{-\beta} & \text{if } n_u \leq n 
\end{cases}
$$

Small Firms
“Bulge”
“Valley”
Large Firms

• $\beta$ = “slope” of power law in firm size = $\beta_\alpha (1-\theta) + \theta$

• Tax, $\tau$, affects shift in ‘intercept’ of power law & size of ‘bulge’ & ‘valley’

$$
T = \tau^{-\frac{\beta-1}{1-\theta}}.
$$
ECONOMETRICS

• Since we have fully characterized firm size distribution we estimate parameters by straightforward ML to obtain $\tau$, $\beta$, $n_U$, $\sigma$ and $F/w$

• ML estimation of broken power law follows physics literature (e.g. Howell, 2002), but we also compare with OLS + structural breaks (e.g. Bai and Perron, 1998)

• Also need estimate of $\theta$, returns to scale to identify the implicit tax:

$$T = \tau^{-\frac{\beta - 1}{1 - \theta}}.$$
IDENTIFICATION OF THE TAX (FIRM SIZE POWER LAW IN LOG-LOG SPACE)
IDENTIFICATION OF THE TAX

Slope is $\beta$
IDENTIFICATION OF THE TAX

Tax identified from
i) shift in the intercept
IDENTIFICATION OF THE REGULATORY TAX

Tax identified from:

i) shift in the intercept
ii) “bulge” & “valley”

Note: Fixed cost of regulation (F) only affects bulge & valley & not shift in intercept
FIG 4: THEORETICAL FIRM SIZE DISTRIBUTION (WITH MEASUREMENT ERROR, $\sigma$)
EMPIRICAL IMPLEMENTATION

• Equilibrium Firm size distribution (pdf of n*):
  • $\beta$ = "slope" of power law in firm size
  • Tax = change in intercept

Tax partly identified from "bulge" at 49 & "valley"
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DATA

  - Mandatory fiscal returns of all French firms ("FICUS")
  - DADS (for some extra info on workers, e.g. hours, skills)
  - This is the administrative unit that the main law pertains to.

- FICUS has balance sheet information on value added, labor, capital, investment, wage bills, materials, 4 digit industry, etc.
  - Use this to calculate TFP via several methods (Levinsohn-Petrin, Olley Pakes, Solow residual, etc.)
FIG 5A: EMPIRICAL FIRM SIZE DISTRIBUTION – SLOPE, BULGE, VALLEY & INTERCEPT SHIFT

Note: Another regulatory break at 10 so focus on firms between 10 and 1000. Consider second threshold at 10 in Extensions
FIG 6: TFP & SIZE RELATIONSHIP: CONSISTENT WITH THEORY THERE IS A BULGE IN TFP AROUND THE REGULATORY THRESHOLD
OUTLINE

1. Theory: Lucas in France

2. Empirical Implementation

3. Data

4. Results
   • Main findings
   • Robustness/Extensions
<table>
<thead>
<tr>
<th>Parameter</th>
<th>θ, Returns</th>
<th>0.8 (Basu-Fernald)</th>
<th>0.85 (Atkeson-Kehoe)</th>
<th>θ=0.5</th>
<th>θ=0.9</th>
</tr>
</thead>
<tbody>
<tr>
<td>τ-1, Implicit variable tax</td>
<td>0.023 (0.008)</td>
<td>0.017 (0.006)</td>
<td>0.059 (0.021)</td>
<td>0.007</td>
<td></td>
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<tr>
<td>β, power law</td>
<td>1.800 (0.054)</td>
<td>1.800 (0.054)</td>
<td>1.800 (0.054)</td>
<td>1.813</td>
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<tr>
<td>n_u, upper</td>
<td>59.271 (2.051)</td>
<td>59.265 (2.026)</td>
<td>59.271 (2.052)</td>
<td>52.985</td>
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<tr>
<td>emp. cutoff</td>
<td>(0.033)</td>
<td>(0.032)</td>
<td>(0.033)</td>
<td>(0.003)</td>
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<tr>
<td>σ, msremnt. error</td>
<td>0.196 (0.075)</td>
<td>0.146 (0.055)</td>
<td>0.517 (0.206)</td>
<td>0.016</td>
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</table>

**TABLE 1: ML ESTIMATES OF PARAMETERS**

Notes: 57,008 (manufacturing size 10-1,000) in year 2000; estimates by ML with standard errors clustered at the 4 digit industry level.
FIG 7 FIRM SIZE DISTRIBUTION: ACTUAL AND FITTED

Notes: Baseline specification Table 1 column (1).
<table>
<thead>
<tr>
<th>(Actual data)</th>
<th>Firms having 10 to 48 workers</th>
<th>Firms having 49 to 59 workers</th>
<th>Firms having 60 to 10,000 workers</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distribution of firms (actual)</td>
<td>0.761</td>
<td>0.042</td>
<td>0.197</td>
<td>1</td>
</tr>
<tr>
<td>Distribution of firms (predicted)</td>
<td>0.758 (0.002)</td>
<td>0.046 (0.009)</td>
<td>0.196 (0.016)</td>
<td>1</td>
</tr>
<tr>
<td>Distribution of employment (actual)</td>
<td>0.300</td>
<td>0.040</td>
<td>0.660</td>
<td>1</td>
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<tr>
<td>Distribution of employment (predicted)</td>
<td>0.276 (0.021)</td>
<td>0.042 (0.008)</td>
<td>0.682 (0.023)</td>
<td>1</td>
</tr>
<tr>
<td>Distribution of output (actual)</td>
<td>0.249</td>
<td>0.035</td>
<td>0.716</td>
<td>1</td>
</tr>
<tr>
<td>Distribution of output (predicted)</td>
<td>0.272 [0.230;0.314]</td>
<td>0.041 [0.025;0.057]</td>
<td>0.686 [0.640;0.732]</td>
<td>1</td>
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<tr>
<td>TABLE 3 WELFARE &amp; DISTRIBUTION</td>
<td>FULL WAGE ADJUST</td>
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<td>(Regulated Economy – Unregulated Economy)</td>
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<tr>
<td>Unemployment rate</td>
<td>0%</td>
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<tr>
<td>Percentage of firms avoiding the regulation</td>
<td>2.920%</td>
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<td>Percentage of firms above the regulatory threshold</td>
<td>10.387%</td>
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<td>Change in labor costs (wage reduction), Small firms (below 49)</td>
<td>-1.792%</td>
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<td>Change in labor costs (wage reduction but tax increase), Large firms (above 49)</td>
<td>0.502%</td>
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<tr>
<td>Excess entry by small firms (percent increase in number of firms)</td>
<td>7.184%</td>
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<td>-2.512%</td>
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<tr>
<td>Annual welfare loss (as % of GDP):</td>
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<tr>
<td>Implicit Tax</td>
<td>1.304%</td>
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<tr>
<td>Output loss</td>
<td>0.022%</td>
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<tr>
<td>Total (implicit tax + output loss)</td>
<td><strong>1.326%</strong></td>
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<tr>
<td>Winners and losers:</td>
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<tr>
<td>Change in expected wage for those in labor force</td>
<td>-1.792%</td>
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<tr>
<td>Av. gain by entering entrepreneurs of small firms</td>
<td>2.667%</td>
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<td>Average profit gain by small unconstrained firms</td>
<td>7.167%</td>
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<td>Average profit gain by firms constrained at 49</td>
<td>6.061%</td>
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<tr>
<td>Change in profit for large firms</td>
<td>-1.159%</td>
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<tr>
<td></td>
<td>FULL WAGE  ADJUST</td>
<td>PARTIALLY FLEXIBLE (50%)</td>
<td>FULLY RIGID</td>
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<tr>
<td>Unemployment rate</td>
<td>0%</td>
<td>4.373%</td>
<td>8.541%</td>
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<td>Percentage of firms avoiding the regulation</td>
<td>2.920%</td>
<td>2.818%</td>
<td>-8.928%</td>
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<td>Excess entry by small firms (percent increase in number of firms)</td>
<td>7.184%</td>
<td>7.171%</td>
<td>4.484%</td>
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<tr>
<td>Increase in size of small firms</td>
<td>8.958%</td>
<td>4.472%</td>
<td>0</td>
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<tr>
<td>Increase in size of large firms</td>
<td>-2.512%</td>
<td>-6.998%</td>
<td>-11.470%</td>
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<tr>
<td>Annual welfare loss (as % of GDP): Implicit Tax</td>
<td>1.304%</td>
<td>1.301%</td>
<td>1.308%</td>
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<td>Output loss</td>
<td>0.022%</td>
<td>3.599%</td>
<td>7.165%</td>
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<td>Total (implicit tax + output loss)</td>
<td><strong>1.326%</strong></td>
<td><strong>4.900%</strong></td>
<td><strong>8.463%</strong></td>
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<td>3.578%</td>
<td>0</td>
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<td>2.472%</td>
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<td>-1.159%</td>
<td>-4.748%</td>
<td>-8.326%</td>
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</table>
TABLE 10 JOB CHANGES BY TYPE OF AGENT: FULLY FLEXIBLE REAL WAGES

<table>
<thead>
<tr>
<th>Workers, in thousands</th>
<th>Small firms</th>
<th>Medium size firms</th>
<th>Large firms</th>
<th>Overall</th>
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<tbody>
<tr>
<td>Under 50 employees</td>
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<tr>
<td>50-59 employees</td>
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<td>60+ employees</td>
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</table>
TABLE 10: JOB CHANGES BY TYPE OF AGENT: PARTIALLY FLEXIBLE (50%) REAL WAGES
TABLE 10 JOB CHANGES BY TYPE OF AGENT: FULLY RIGID REAL WAGES
TABLE 10 WELFARE CHANGES BY TYPE OF AGENT

Fully Flexible Real Wages

<table>
<thead>
<tr>
<th></th>
<th>Workers</th>
<th>Entrants</th>
<th>Small firms</th>
<th>Medium firms</th>
<th>Large firms</th>
<th>Overall</th>
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<tbody>
<tr>
<td>Change in earnings</td>
<td>-6</td>
<td>-4</td>
<td>-2</td>
<td>0</td>
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<td>Output loss</td>
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<td>Tax</td>
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<td>-4</td>
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# TABLE 10 WELFARE CHANGES BY TYPE OF AGENT

### Fully Flexible Real Wages

<table>
<thead>
<tr>
<th>Gains and losses, in %</th>
<th>Workers</th>
<th>Entrants</th>
<th>Small firms</th>
<th>Medium firms</th>
<th>Large firms</th>
<th>Overall</th>
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<td>Change in earnings</td>
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### Partially Flexible Real Wages

<table>
<thead>
<tr>
<th>Gains and losses, in %</th>
<th>Workers</th>
<th>Entrants</th>
<th>Small firms</th>
<th>Medium firms</th>
<th>Large firms</th>
<th>Overall</th>
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<tbody>
<tr>
<td>Change in earnings</td>
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### Inflexible Real Wages

<table>
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<tr>
<th>Gains and losses, in %</th>
<th>Workers</th>
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<td>Change in earnings</td>
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<td>Output loss</td>
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<td>Tax</td>
<td></td>
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</tr>
</tbody>
</table>
WELFARE & DISTRIBUTION: SUMMARY

• With flexible wages welfare loss small (~1% of GDP)
  – Ranking of firm size by managerial ability stable (Hopenhayn, 2014)
• But big distributional change
  – Workers lose as they bear cost of regulation through lower wages
  – Large firms lose as lower wages do not fully offset regulation costs
  – Small Firms gain from lower costs & more entrepreneurs

• With inflexible wages (unions, minimum wages, etc.) much bigger welfare costs due to unemployment
  – For partially inflexible ~5%
  – Similar pattern of redistribution
OUTLINE

1. Theory: Lucas in France

2. Empirical Implementation

3. Data

4. Results
   • Main findings
   • Robustness/Extensions
EXTENSIONS & ROBUSTNESS

- Do workers benefit from the “mandated benefit” & take lower wages (Lazear, 1990; Summers, 1989)?
  - Not in our data
- Big firms pretending to be small?
- Other margins of adjustment (e.g. capital)
- Dynamics (another explanations for the “Valley”)
- Industry Heterogeneity
- Alternative calculations based on MRPL a la Hsieh-Klenow (2009)
- Allow for another discontinuity at size=10
FIG 11: NO EVIDENCE THAT WORKERS ARE ACCEPTING LOWER WAGES IN RETURN FOR TOUGHER REGULATION
EXTENSIONS & ROBUSTNESS

• Workers benefit from “insurance” & take lower wages?
• Big firms pretending to be small?
  – See effects for standalone firms as well as those part of business groups
  – Misreporting
• Other margins of adjustment (e.g. capital)
• Dynamics (another explanations for the “Valley”)
• Industry Heterogeneity
• Alternative calculations based on MRPL a la Hsieh-Klenow (2009)
• Allow for another discontinuity at size=10
• Robustness – other datasets; different years
RESULTS NOT DRIVEN BY BIG BUSINESS GROUPS PRETENDING TO BE SMALL (FIG A4)
EXTENSIONS & ROBUSTNESS

• Workers benefit from “insurance” & take lower wages?
• Big firms pretending to be small?
  – See effects for standalone firms as well as those part of business groups
  – Misreporting
• Other margins of adjustment (e.g. capital)
• Dynamics (another explanations for the “Valley”)
• Industry Heterogeneity
• Alternative calculations based on MRPL a la Hsieh-Klenow (2009)
• Allow for another discontinuity at size=10
• Robustness
FIG 12 - OTHER ADJUSTMENTS AROUND THE THRESHOLD: MORE INVESTMENT PER WORKER
FIG A6 - OTHER ADJUSTMENTS AROUND THE THRESHOLD: MORE HOURS PER WORKER
EXTENSIONS: Other margins of adjustment

• Substitution reduces costs to firms, but still distortion unless perfect substitutes
• Our good predictions on output (Table 3) suggest these other margins of substitution are not first order
• Implement a formal extension to CES production function:

\[ \alpha f(n,k) = \alpha (\lambda_1 n^\rho + \lambda_2 k^\rho)^{\theta/\rho} \]
Fixed cost part of the tax, $F/w$

Variable cost part of the tax, $\tau$

Elasticity of substitution, $\sigma$

**FIG 13 – ALLOWING FOR CAPITAL-LABOR SUBSTITUTION DOESN’T CHANGE MAIN RESULTS**

Note: Welfare losses similar (see Fig 14). For example for elasticity of sub=1; falls from 1.3% to 1% of GDP.
EXTENSIONS: Dynamics

- Positive mass in valley to right of threshold could be due to adjustment costs (not just measurement error)
- Consider much more general model:
  - Initial draw of TFP & then random shocks each period (AR(1) with 0.95 persistence)
  - Labor & Capital with quadratic adjustment costs
  - Numerically simulate model
- Use value function iteration to calculate policy correspondences
- Draw 20,000 firms & run for 100 years. Distribution settles down after ~50 years so just use last 25 years to characterize long-run employment distribution
Figure 16: Baseline calibration of steady state firm employment size distribution generates similar picture as static model.

Positive mass in valley are firms moving in & out.
Figure 17: As adjustment costs increase valley is “smoothed out”

A. Adjustment costs increased (2x higher)

B. Adjustment costs lower (~10% of baseline)
FIG 18: PROPORTION OF FIRMS GROWING DROPS TO LEFT OF THRESHOLD

A. Actual data

B. Simulated data
CONCLUSIONS

• Simple method for quantifying effect of size-related regulations & explains qualitative features of data
• Big changes in distribution: workers & large firms lose but smaller firms win
• Small losses under 1% GDP if real wages perfectly downwards flexible, but ~5% if partially inflexible wages

• Some Next Steps:
  – Re-calculate regulatory tax based on dynamic model
  – Let TFP be influenced by endogenous innovation decisions (e.g. increased penalty of growing may reduce investment incentives)
  – Build in other size-related regulations
  – Other settings for methodology: ACA?
Back Up
Mapping between alternative formulations of fixed cost of regulation

\[ \pi(\alpha) = \max_n \begin{cases} 
\alpha f(n) - wn & \text{if } n \leq N \\
\alpha f(n) - w(N + \tau(n - N)) - F & \text{if } n > N 
\end{cases} \]

If we changed regulatory costs for firms above threshold from:

\[ wN + (n - N)\tau + F' \]

To the alternative where costs are on all workers

\[ w\tau' n + F' \]

Then this is simply a re-mapping of estimates of costs:

\[ \tau = \tau'; \]

\[ F = F' + (\tau' - 1)wn \]
FIG 14 WELFARE LOSSES IN THE CES MODEL

Panel A: Fully flexible wages

Panel B: Fully rigid wages
FIG 16B PROPORTION OF FIRMS SHRINKING BY MORE THAN 10%
FIG A1 HETEROGENEITY OF THE ESTIMATES ACROSS DIFFERENT THREE DIGIT INDUSTRIES
DISTRIBUTIONAL EFFECTS OF REGULATION ACROSS AGENTS

Losers

Winners

Losers

\[
\text{Income} \quad 0.01 \quad 0.02 \quad 0.03 \quad 0.04
\]

\[
\text{Diff. in ln(income) (with tax - w/o tax)}
\]

\[
\text{With tax reallocated to workers}
\]
COMPARISON WITH HSIEH-KLENOW APPROACH: MARGINAL REVENUE PRODUCTIVITY OF LABOR

Productivity index vs. Employment

- **Productivity index alpha**
- **Marginal product of labor**
FIG A3: MRPL SUGGESTS A TAX OF 3-4% (SAME AS MAIN RESULTS WHEN WE USE H-K θ=.5)

Note: This is data on value added per worker relative to the four digit industry average
EXTENSIONS

• Industry heterogeneity
  – Some heterogeneity (e.g. Table 5 over)
  – Estimate separately for more disaggregated industries (Tab A4)
  – Sensible heterogeneity, e.g. higher implicit tax when labor a larger share of total value added
<table>
<thead>
<tr>
<th>Experiment</th>
<th>Manufacturing</th>
<th>Transport</th>
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<th>Business Services</th>
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<td>$\beta$, power law</td>
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<td>(0.054)</td>
<td>(0.098)</td>
<td>(0.122)</td>
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<td>41,067</td>
<td>10,907</td>
<td>23,506</td>
<td>41,071</td>
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**Notes:** Size 10-1,000 employees; estimates by ML with standard errors clustered at the 4 digit level; returns to scale = 0.8; year 2000
EXTENSIONS

• Hsieh-Klenow (2009) approach
  – Calculate marginal revenue productivity near threshold
  – How much does this change between “constrained” firms and “unconstrained” firms?

• Issues with approach
  – Those on immediate sides of threshold not comparable
  – Measuring MRP non-trivial (e.g. overhead labor)

• Nevertheless, find broadly consistent results (Tab A2, A3)
  – Regulatory tax 3-4% (so bigger than our baseline estimates)
GENERALIZE MODEL TO ALSO ALLOW FOR REGULATION AT SIZE = 10

- Extend method to allow for an additional variable & fixed cost after 10 employees (recall smaller discontinuity here)
- Estimate variable cost ≈ 0. Fixed cost at 10 is about 10% of fixed cost at 50 employees (Table A3)
- Welfare loss from 10 is 0.06% of GDP (compared to 1% at 50) under the flexible wage case (0.3% vs. 5% under the rigid wage case (Table A4).
OTHER ROBUSTNESS

• Estimate on other datasets (DADs in Tab A5)
• Estimate on different years between 1995 and 2007 (Table A1)
  – Taxes pretty stable (variable 1.7% to 2.3%; fixed 15.2% to 23.3%)
• Alternative assumptions over upper bound of firm size distribution