Creative Destruction and Firm Organization Choice

David Thesmar and Mathias Thoenig (QJE 2000)

Presented by Beatriz González
Macroeconomics Reading Group - UC3M

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Organizational choices represent a trade-off: efficiency vs. adaptability.

- Larger organizations allow productivity gains.
- Larger organizations resists implementation of innovations.
  → Implementation costs are positively correlated with complexity of organizational design.
Aim of the paper

Assess the interaction between organizational choice and the macroeconomy.
Introduction

Aim of the paper

Assess the interaction between organizational choice and the macroeconomy.

- Schumpeterian growth theory à la Aghion and Howitt.
- Creative destruction rate brings product market instability.
- Skilled vs Unskilled workers.
- R&D sector: sell patent to producing sector.
- Producing sector: face organizational problem.
  - Mechanistic. High productivity at expense of a sunk cost.
  - Organistic. Low productivity without sunk cost.

The theory provides:

- Macroeconomic foundation for endogenizing segregation by skill.
- Explanation for:
  - Increase in the relative supply of skilled workers.
  - Increase in skill premium.
  - Decrease in the unskilled real wage.
- Predicts that the degree of specialization in production decreases with market size.
- Globalization between similar countries may have strong consequences for a firms’ organization and labor demand.
The Model

- Continous time, continuum of goods.
- Two types of labor: skilled (H) and unskilled (U)
- Consumption index:

$$\ln C_t = \int_0^1 \ln(\lambda^{s(i)} c_t(i)) di$$  \hspace{1cm} (1)

- $\lambda > 1$ quality improvement step.
- $s(i)$ is the number of innovations experienced by good i.
- $c_t(i)$ is the quantity of good i consumed at t.
- R&D sector. Creates undirected innovation according to a Poisson process $\theta$.

$$b\theta = h^{RD}$$  \hspace{1cm} (2)
The Model

▶ Producer sector. For each sector $i$,
  ▶ Produce $y = ah^\alpha u^{1-\alpha}$
  ▶ Unit cost function $\frac{uc(w_s, w_u)}{a}$

▶ Buy a patent:
  ▶ High productivity $\bar{a} +$ sunk cost.
  ▶ Low productivity $a$.

→ Isomorphic to choice of IRS vs CRS technology.
Competition at Microeconomic Level

- Bertrand competition.
- New entrant will crowd out the market if

$$\lambda a > a_{-1} \quad (3)$$

- Expected value of profits.

$$V(a; a_{-1}, \theta) = \frac{(1 - a_{-1})/\lambda a}{r + \theta} - C\Pi_{|a=\bar{a}|} \quad (4)$$

- Entrant’s reaction function.

$$a^*(a_{-1}, \theta) = \begin{cases} a & \text{if } \theta > a_{-1} \frac{\Delta a}{\bar{a}a\lambda C} - r \\ \bar{a} & \text{if } \theta < a_{-1} \frac{\Delta a}{\bar{a}a\lambda C} - r \end{cases}$$
Proposition 1

1. **CRS equilibrium.** All firms choosing $a$ is an equilibrium if and only if

$$\theta > \frac{\Delta a}{\lambda C\bar{a}} = \theta$$

2. **IRS equilibrium.** All firms choosing $\bar{a}$ is an equilibrium if and only if

$$\theta < \frac{\Delta a}{\lambda C\bar{a}} = \bar{\theta}$$

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Thesmar, Thoenig (2000)  
*Creative Destruction and Firm Organization Choice*
General Equilibrium

Restrict to stationary symmetric equilibria.

\[ V(\theta) = 1 - \frac{1}{\lambda} r + \theta - CI|a = \bar{a}| \]

Choice of technology:

\[ a = \bar{a} \text{ if } \theta < \bar{\theta} \]
\[ a = a \text{ if } \theta > \theta \]

Free entry in R&D.

\[ b_{ws} = V(\theta) \]

Labor market clearing conditions.

\[ H = b_\theta \theta + \alpha \lambda w_s U = (1 - \alpha) \lambda w_u \]

Figure: Aggregate Labor Demand in CRS and IRS equilibria.
General Equilibrium

Restrict to stationary symmetric equilibria.

- Price of innovation = Value of the firm.

\[ V(\theta) = \frac{1 - 1/\lambda}{r + \theta} - C_{|a=\bar{a}|} \]  \hspace{1cm} (5)
General Equilibrium

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- Price of innovation = Value of the firm.

\[ V(\theta) = \frac{1 - 1/\lambda}{r + \theta} - C_{I|a=\bar{a}} \]  

- Choice of technology

\( a = \bar{a} \) if \( \theta < \bar{\theta} \) and \( a = a \) if \( \theta > \bar{\theta} \)
General Equilibrium

Restrict to stationary symmetric equilibria.

- Price of innovation = Value of the firm.

\[
V(\theta) = \frac{1 - \frac{1}{\lambda}}{r + \theta} - C\Pi|_{a=\bar{a}}
\]  

(5)

- Choice of technology

\[a = \bar{a} \text{ if } \theta < \bar{\theta} \text{ and } a = a \text{ if } \theta > \bar{\theta}\]

- Free entry in R&D.

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- Choice of technology
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- Free entry in R&D.
  \[ bw_s = V(\theta) \]

- Labor market clearing conditions.
  \[ H = b\theta + \frac{\alpha}{\lambda}w_s \]
  \[ U = \frac{(1 - \alpha)}{\lambda}w_u \]

Figure.- Aggregate Labor Demand in CRS and IRS equilibria.

General Equilibrium

**Proposition 2**

∃($H$, $\bar{H}$) such that $H < \bar{H}$ and

1. If $H < H$, then the economy is IRS in all sectors.
2. If $H > \bar{H}$, then the economy is CRS in all sectors.
3. If $H \leq H \leq \bar{H}$, both equilibrium exist.

Thesmar, Thoenig (2000)  
*Creative Destruction and Firm Organization Choice*
Discussion

Change in organizational structure $IRS \rightarrow CRS$

Given $H \in \{H, \bar{H}\} \rightarrow$ Change in equilibrium from IRS to CRS.

- **Result 1.** The rate of creative destruction is higher in the CRS equilibrium ($\theta_{CRS} > \theta_{IRS}$), and the stock market value of a firm is higher ($V_{CRS} > V_{IRS}$).
Discussion

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- **Result 2.** The production level is lower in the organistic CRS equilibrium ($X_{CRS} < X_{IRS}$).
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- Equilibrium wages:
  - 'Disorganization effect' ($a < \bar{a}$) lowers both $w_u$ and $w_s$.
  - Skilled workers leave production for research $\rightarrow$ marginal gain of hiring skilled workers go down.
  - Demand for labor in R&D is higher $\rightarrow$ increase $w_s$. 

Thesmar, Thoenig (2000)  
*Creative Destruction and Firm Organization Choice*
Discussion

Change in organizational structure IRS → CRS

> Result 3. Wage inequality, as measured by the skill premium, is higher in the CRS equilibrium than in the IRS one.

\[
\left(\frac{w_s}{w_u}\right)_{CRS} > \left(\frac{w_s}{w_u}\right)_{IRS}.
\]

\[
\frac{w_s}{w_u} = \left(\frac{\alpha}{1 - \alpha}\right) \frac{U}{H - b\theta}
\]  

(6)
Discussion
Market Size and Organizational Change

- Number of sectors in the economy is of measure \( N \).

\[
\frac{H}{N} = b\theta + \frac{(r + \theta)}{(\lambda - 1 - C\lambda(r + \theta)I_{|a=\bar{a}})} \quad (7)
\]
Discussion

Market Size and Organizational Change

- Number of sectors in the economy is of measure $N$.

$$
\frac{H}{N} = b\theta + \frac{(r + \theta)}{(\lambda - 1 - C\lambda(r + \theta)I_{a=\bar{a}})}
$$

- Expansion of market size → If $N$ remains fixed, the expansion is favorable to CRS equilibrium.
  - Coordination costs exert a more stringent constraint than market size.
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Market Size and Organizational Change

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$$\frac{H}{N} = b\theta + (r + \theta)/(\lambda - 1 - C\lambda(r + \theta)I_{|a=a|})$$  \hspace{1cm} (7)

- Expansion of market size $\rightarrow$ If $N$ remains fixed, the expansion is favorable to CRS equilibrium.
  - Coordination costs exert a more stringent constraint than market size.
- Hysteresis along the transition path.

Figure II
Short-Run and Long-Run Effects of a Larger Market Size
Discussion

Increase in Skilled Labor Force


- Askenazy (1999): most sectors that have reorganized did so in the mid-1980s.
Discussion

Increase in Skilled Labor Force

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- Assume \( N = U + H \) \( \rightarrow \) Increase in the share of skilled labor may shift the economy to the CRS equilibrium.
  - Supply effect: reduces inequality through lowering skilled wage.
  - Organizational effect: occurs if skilled labor supply hits the upper bound \( H/N \)
Discussion

Increase in Skilled Labor Force


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- Assume $N = U + H \rightarrow$ Increase in the share of skilled labor may shift the economy to the CRS equilibrium.
  - Supply effect: reduces inequality through lowering skilled wage.
  - Organizational effect: occurs if skilled labor supply hits the upper bound $\frac{H}{N}$

Model is able to generate comovement between the share of skilled labor and the skill premium.

Figure.-Increase in Skilled Labor Supply and Equilibrium Shift.
Discussion

Economic Integration

Economic integration of two countries with identical labor endowments $N_i = U_i + H_i$, $N$ exogenous.

- **Case A.** Both countries produce goods that are completely different.
  - Number of sectors increases $(N_1 + N_2) = (U_1 + U_2 + H_1 + H_2)$
  - Sectorial $\theta$ does cont change since share of skilled labor remains constant.
Discussion

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- **Case A.** Both countries produce goods that are completely different.
  - Number of sectors increases \((N_1 + N_2) = (U_1 + U_2 + H_1 + H_2)\)
  - Sectorial \( \theta \) does cont change since share of skilled labor remains constant.

- **Case B.** Both countries produce exactly the same goods.
  - Number of sectors increases remains intact
  - Sectorial \( \theta \) rises, and the integrated economy may shift from the IRS equilibrium to the CRS equilibrium.
    - Firms change organizational structure.
    - Inequality rises.

Macroeconomic Evidence

**Data:** French Survey of the Structure of Employment in firms (INSEE)

- Provides information on both skill and function at the firm level.

**TABLE I**

<table>
<thead>
<tr>
<th>Function</th>
<th>Administration</th>
<th>Commercialization</th>
<th>Production</th>
<th>Logistics</th>
<th>Development</th>
</tr>
</thead>
<tbody>
<tr>
<td>Share in total employment (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1984</td>
<td>18.5</td>
<td>11.4</td>
<td>51.6</td>
<td>13.7</td>
<td>4.90</td>
</tr>
<tr>
<td>1995</td>
<td>18.0</td>
<td>15.4</td>
<td>44.4</td>
<td>14.7</td>
<td>7.50</td>
</tr>
<tr>
<td>Share of skilled workers (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1984</td>
<td>35.7</td>
<td>55.8</td>
<td>14.8</td>
<td>15.5</td>
<td>100</td>
</tr>
<tr>
<td>1995</td>
<td>43.7</td>
<td>54.3</td>
<td>17.2</td>
<td>15.9</td>
<td>100</td>
</tr>
</tbody>
</table>

*Source.* Employment structure survey [ESE 1984, 1995].

All French Establishments of more than twenty employees except in Household Services, Health Care, and Education. Employment is measured in terms of distinct individuals. Skill measure is derived from the detailed French socioprofessional classification and depends on education level and experience. All numbers are percentage point changes.

- Figure.- Share of Skilled Jobs in France
Macroeconomic Evidence

Main Findings

- Sectorial reallocation has little explicative power with regard to the aggregate skill upgrading of French jobs.

Macroeconomic Evidence

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- Sectorial reallocation has little explicative power with regard to the aggregate skill upgrading of French jobs.

- Functional reallocation explains more than half of the aggregate skill upgrading.

Thesmar, Thoenig (2000) 
Creative Destruction and Firm Organization Choice
Macroeconomic Evidence

Main Findings

- Sectorial reallocation has little explicative power with regard to the aggregate skill upgrading of French jobs.

- Functional reallocation explains more than half of the aggregate skill upgrading.

- Economywide reorganization should result in a rise in the rate of creative destruction.
  - Increased share of value added devoted to R&D and increase in the number of patents filed.
Microeconomic Evidence

Main Results

- Very negative and significant correlation between product turnover (proxy for creative destruction) and allocation of employment to production.

Rise in Rate of Creative Destruction

Microeconomic Evidence

Main Results

- Very negative and significant correlation between product turnover (proxy for creative destruction) and allocation of employment to production.

  ▶ Rise in Rate of Creative Destruction

- Negative relation between development effort and the share of production workers.

  ▶ Rise in Rate of Creative Destruction

Conclusions

- Embed firm’s choice of organizational structure in a model of growth through creative destruction $\rightarrow$ endogenous market volatility.
- Provide comparative statistics dealing with aggregate product market instability and:
  - Labor markets
  - Organizational choices.
  - Economic integration
- Find that firm-level data provides a picture consistent with the model.

'The view expressed in this paper is that there is no obvious reason why technical progress should be more skilled biased than it was 50 years ago. However, we argue that a move toward more decentralization and horizontal communication in the organization of firms intrinsically favors skilled labor to the disadvantages of the unskilled.'
Any questions?
Thank you!
Aggregate Labor Demand in CRS and IRS equilibria

**Figure I**
Aggregate Labor Demand in CRS and IRS Equilibria

**Proposition 2.** Description of Equilibria: 3(H,H) such that H < H

1. if H ' H then the economy is IRS in all sectors;
2. if H H, then the economy is CRS in all sectors;
3. if H ' H < H. both equilibria coexist.

This result highlights the key role of a second strategic complementarity that arises in general equilibrium through the R&D sector. Indeed, let all other firms choose to be CRS. As noted above, this common strategy raises their value, and hence R&D's marginal productivity (recall that the labs' expected flow of profits is given by \( V/b \) * hRD), which in turn raises R&D's output, i.e., the growth rate \( \theta \). But from Proposition 1 we know that a higher rate of creative destruction generates an externality on the sectors' choices, rendering more likely the existence of a CRS equilibrium.

In summary, the externality that firms' decisions impose on 15. Note that this effect is robust to a Decreasing Returns to Scale specification of the R&D technology: \( \theta = la/b \).
Aggregate Labor Demand in CRS and IRS equilibria

**Figure III**
Increase in Skilled Labor Supply and Equilibrium Shift
Share of Skilled Jobs in France

Figure IV
Share of Skilled Jobs in France: 1984–1995
Macroeconomic Evidence

Sectorial and Functional Reallocation and Skill Upgrading

\[
\Delta \frac{H}{N} = \sum_{i=1}^{M} \Delta \frac{h_i}{n_i} \frac{\bar{n}_i}{N} + \sum_{i=1}^{M} \Delta \frac{\bar{h}_i}{n_i} \frac{n_i}{N}
\]

(8)

Within component

Between component

Table II

<table>
<thead>
<tr>
<th>Years</th>
<th>84–90</th>
<th>90–95</th>
<th>84–95</th>
</tr>
</thead>
<tbody>
<tr>
<td>D(Skilled)</td>
<td>4.02</td>
<td>2.06</td>
<td>6.08</td>
</tr>
<tr>
<td>Between sector</td>
<td>0.42</td>
<td>−0.03</td>
<td>0.09</td>
</tr>
<tr>
<td>Within sector</td>
<td>3.60</td>
<td>2.09</td>
<td>5.09</td>
</tr>
</tbody>
</table>


All French Establishments of more than twenty employees except in Household Services, Health Care and Education. Employment is measured in terms of distinct individuals. Skill measure is derived from the detailed French socioprofessional classification and depends on education level and experience. The table variables refer to the Berman, Bound, and Griliches [1994] decomposition. The percentage increase in skilled employment \(D(Skilled)\) in the sample is equal to the sum of two terms. The first is the sum of net percentage increases in each sector’s employment, weighted by this sector’s share of skilled workers in employment (Between sector). The second term is the sum of sectorial increases in skilled employment, weighted by each sector’s share in total employment (Within sector). To define sectors, we used a two-digit classification (70 sectors).

All numbers are percentage point changes.
### Table III

**Functional Reallocation and Skill Upgrading**

<table>
<thead>
<tr>
<th>Years</th>
<th>84–90</th>
<th>90–95</th>
<th>84–95</th>
</tr>
</thead>
<tbody>
<tr>
<td>D((\text{skilled}))</td>
<td>4.02</td>
<td>2.06</td>
<td>6.08</td>
</tr>
<tr>
<td>Between function</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Administration</td>
<td>0.10</td>
<td>-0.29</td>
<td>-0.17</td>
</tr>
<tr>
<td>Commercialization</td>
<td>0.98</td>
<td>1.25</td>
<td>2.21</td>
</tr>
<tr>
<td>Production</td>
<td>-0.62</td>
<td>-0.56</td>
<td>-1.16</td>
</tr>
<tr>
<td>Logistics</td>
<td>0.12</td>
<td>0.04</td>
<td>0.16</td>
</tr>
<tr>
<td>Development</td>
<td>1.17</td>
<td>1.42</td>
<td>2.60</td>
</tr>
<tr>
<td>Total</td>
<td>1.76</td>
<td>1.88</td>
<td>3.65</td>
</tr>
<tr>
<td>Within function</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Administration</td>
<td>1.04</td>
<td>0.43</td>
<td>1.45</td>
</tr>
<tr>
<td>Commercialization</td>
<td>0.07</td>
<td>-0.29</td>
<td>-0.19</td>
</tr>
<tr>
<td>Production</td>
<td>0.97</td>
<td>0.17</td>
<td>1.12</td>
</tr>
<tr>
<td>Logistics</td>
<td>0.17</td>
<td>-0.11</td>
<td>0.06</td>
</tr>
<tr>
<td>Development</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>2.25</td>
<td>0.19</td>
<td>2.43</td>
</tr>
</tbody>
</table>


All French establishments of more than twenty employees except in Household Services, Health Care, and Education. Employment is measured in terms of distinct individuals. Skill measure is derived from the detailed French socioprofessional classification and depends on education level and experience. The table variables refer to a variant of the Berman, Bound, and Griliches [1994] decomposition. The percentage increase in skilled employment \((D(\text{skilled}))\) in the sample is equal to the sum of two terms. The first is the sum of net percentage increases in each function employment weighted by this function's share of skilled workers in employment (Between function). The second term is the sum of increases in skilled employment within each function, weighted by this function's share in total employment (Within function). Recall that functions are decomposed into five categories, while sectors are decomposed into 70 categories.

All numbers are percentage point changes.
### Macroeconomic Evidence

#### Rise in Rate of Creative Destruction

![Figure VI](image)

**Figure VI**

Patents Applied for in France and Patents Granted in the United States

*Source* Patent Offices, France and the United States.

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Griliches, 1990; Gottschalk and Moffit, 1994; Thesen and Thoenig, 2000
Microeconomic Evidence

- **Dependent variable**: PR, share of production workers.
- **Independent variable**: NPR, share of new products in total sales

### TABLE IV

**INNOVATION TURNOVER AND FUNCTION REALLOCATION**

<table>
<thead>
<tr>
<th>Share of production workers</th>
<th>Model 1</th>
<th>Model 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Share of new products in total sales (86–90)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Between 10 and 30%</td>
<td>-0.05</td>
<td>-0.05</td>
</tr>
<tr>
<td></td>
<td>(11.44)</td>
<td>(10.88)</td>
</tr>
<tr>
<td>Between 30 and 70%</td>
<td>-0.07</td>
<td>-0.06</td>
</tr>
<tr>
<td></td>
<td>(9.54)</td>
<td>(8.82)</td>
</tr>
<tr>
<td>More than 70%</td>
<td>-0.09</td>
<td>-0.08</td>
</tr>
<tr>
<td></td>
<td>(5.31)</td>
<td>(4.9)</td>
</tr>
<tr>
<td>Employment (1e-6)</td>
<td>—</td>
<td>-3.58</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(1.57)</td>
</tr>
<tr>
<td>Observations</td>
<td>11233</td>
<td>11233</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.02</td>
<td>0.06</td>
</tr>
</tbody>
</table>

*Source.* Enquête Innovation and Enquête Structure des Emplois (balanced panel).
The dependent variable is the average of the 1986 and 1990 shares of production workers.
The equations are estimated through OLS with White (1980) correction for arbitrary heteroskedasticity.
Model 2 includes the total employment and fifteen sectorial dummies as additional regressors.
Microeconomic Evidence

- **Dependent variable:** PR, share of production workers.
- **Independent variable:** DNP, number of workers devoted to development of new products.

### TABLE V
**DEVELOPMENT EFFORT AND FUNCTION REALLOCATION**

<table>
<thead>
<tr>
<th>Share of production</th>
<th>Model 1</th>
<th>Model 2</th>
<th>Model 3</th>
<th>Model 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total employment (1e-6)</td>
<td>—</td>
<td>6.86</td>
<td>—</td>
<td>7.05</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(28.34)</td>
<td></td>
<td>(8.56)</td>
</tr>
<tr>
<td>DNP (1e-6)</td>
<td>-5.66</td>
<td>-13.9</td>
<td>13.4</td>
<td>-41.1</td>
</tr>
<tr>
<td></td>
<td>(3.08)</td>
<td>(7.47)</td>
<td>(0.42)</td>
<td>(4.93)</td>
</tr>
<tr>
<td>Observation</td>
<td>568146</td>
<td>568146</td>
<td>238932</td>
<td>238932</td>
</tr>
<tr>
<td>Fisher statistic</td>
<td>106.6</td>
<td>106.79</td>
<td>0.18</td>
<td>36.8</td>
</tr>
</tbody>
</table>

*Source.* Enquête Structure des Emplois.

*Note.* DNP corresponds to the number of workers in the function *Development of New Products* (R&D and marketing).

Models 1 and 2 use lagged conception employment. They are estimated by OLS with firm-specific effects. Models 3 and 4 use long differences (five years). They are estimated by OLS.

`t`-statistics are in parentheses.