Innovation, Reallocation and Growth

Daron Acemoglu
MIT

Ufuk Akcigit
UPenn

Nick Bloom
Stanford

William Kerr
Harvard

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Motivation

- Increased interest in "industrial policy" to support investment, innovation or employment growth.
  - Estimated EU industrial policy in 2010 approximately 9.6% of EU GDP.
- Standard endogenous technological change models suggest that certain types of industrial policies, e.g., support for R&D, should be growth-enhancing and welfare-improving.
- But potential costs: distorted and slower reallocation.

This Paper

- What are the effects of industrial policies on aggregate innovation and productivity growth?
- Main channel: reallocation of factors.
- This investigation requires a framework incorporating:
  1. different types of policies ,
  2. general equilibrium structure ,
  3. exit for less productive firms/products
  4. meaningful heterogeneity at the firm level .

Model

- Unique final good Y :

$$Y = \left(\int_{\mathcal{N}} y_j^{\frac{\varepsilon-1}{\varepsilon}} dj \right)^{\frac{\varepsilon}{\varepsilon-1}}.$$

  $\mathcal{N} \subset [0,1]$: set of *active* product lines.

- Closed economy: $C = Y$.
- Inelastic labor supply:
  - Unskilled for production: measure 1, earns w^u
  - Skilled for R&D and management: measure L, earns w^s.

Intermediate Good Technology

- Each intermediate good is produced by a **monopolist**:

$$y_{j,f} = q_{j,f} l_{j,f},$$

  $q_{j,f}$: productivity, $l_{j,f}$: unskilled workers.
- Marginal cost:

$$MC_{j,f} = \frac{w^u}{q_{j,f}}.$$

- Fixed cost, ϕ in terms of skilled labor.
- Total cost

$$TC_{j,f}\left(y_{j,f}\right) = w^s \phi + \frac{w^u}{q_{j,f}} y_{j,f}.$$

- Define *relative productivity*:

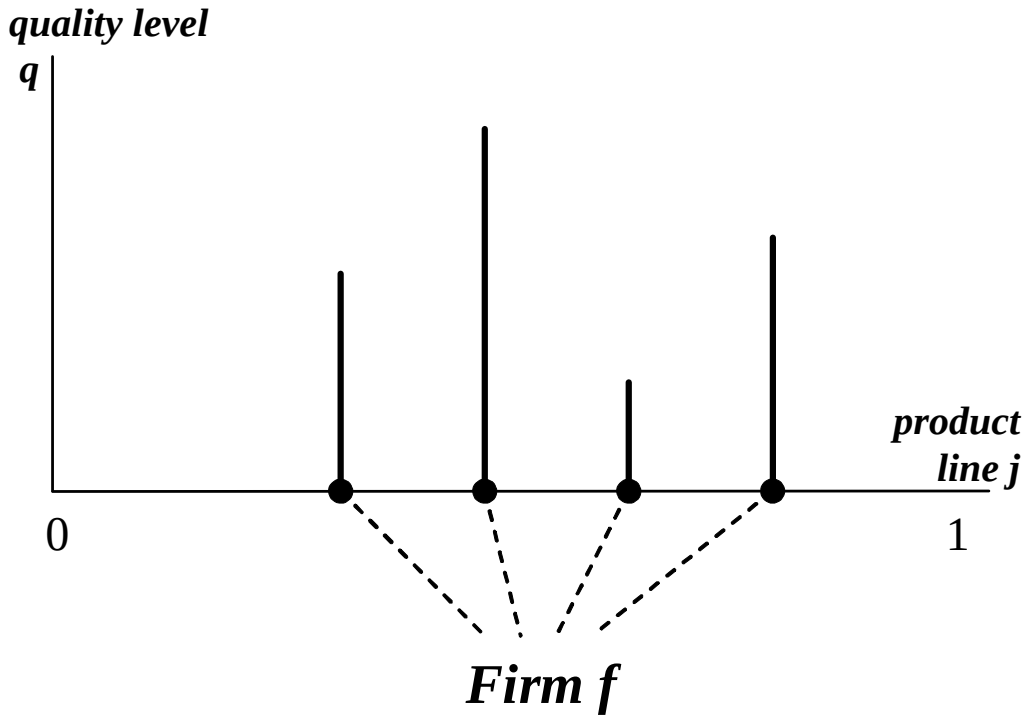
$$\hat{q}_j \equiv \frac{q_j}{w^u}.$$

Definition of a Firm

- A firm: collection of productivities and firm type

$$\text{Firm } f \equiv \left\{ q_f^1, q_f^2, ..., q_f^n;\ \theta \right\}.$$

n_f : number of product lines.



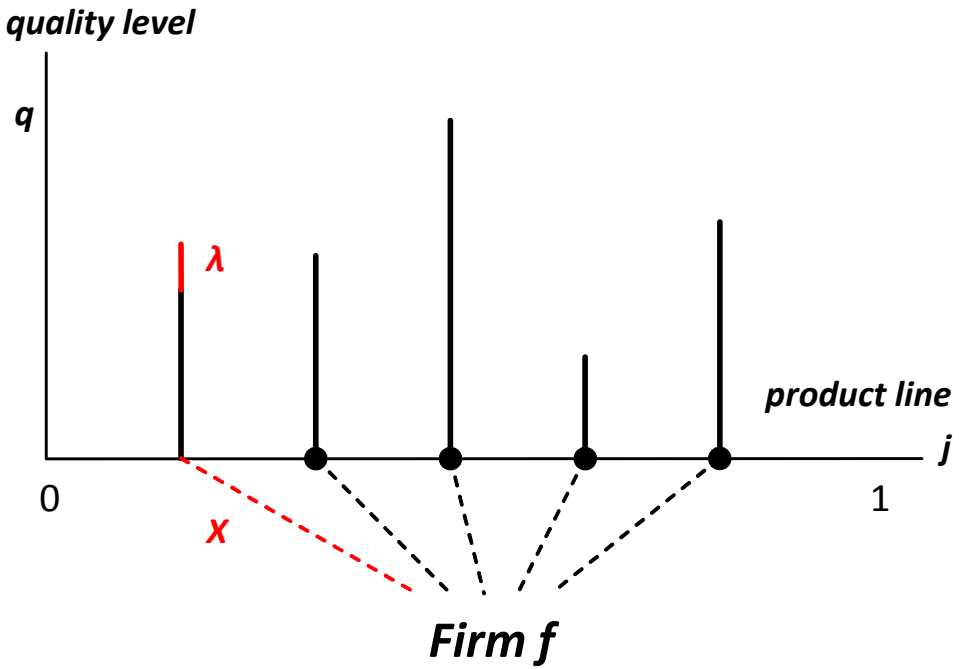
R&D and Innovation

- Innovation rate:

$$X_f = (n_f \theta_f)^{\gamma} h_f^{1-\gamma}.$$

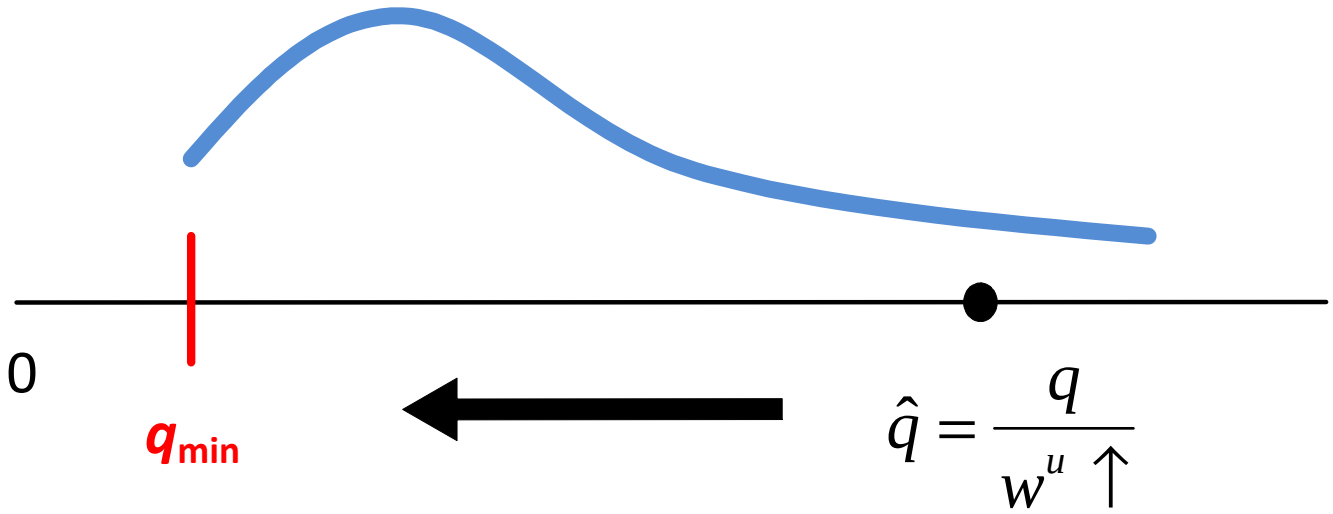
h_f : number of researchers.

- Innovations are *undirected* . Upon an innovation:
  1. firm acquires another product line j
  2. improves its productivity: $q(j, t + \Delta t) = (1 + \lambda) q(j, t)$.



Exit

- Exit happens in three ways:
  1. **Creative destruction**. Each product is lost at the rate $\tau > 0$ due to competition.
  2. **Exogenous destructive shock** at the rate φ.
  3. **Endogenous obsolescence**. Relative quality decreases due to the increase in the wage:



Entry

- Endogenous measure of potential entrants, m. Successful innovators enter.

- At the entry, each firm draws a management quality θ :

$$\theta = \begin{cases} \theta^H \text{ with probability } \alpha \\ \theta^L \text{ with probability } 1-\alpha \end{cases},$$

  where $\alpha \in (0,1)$ and $\theta^H > \theta^L > 0$.

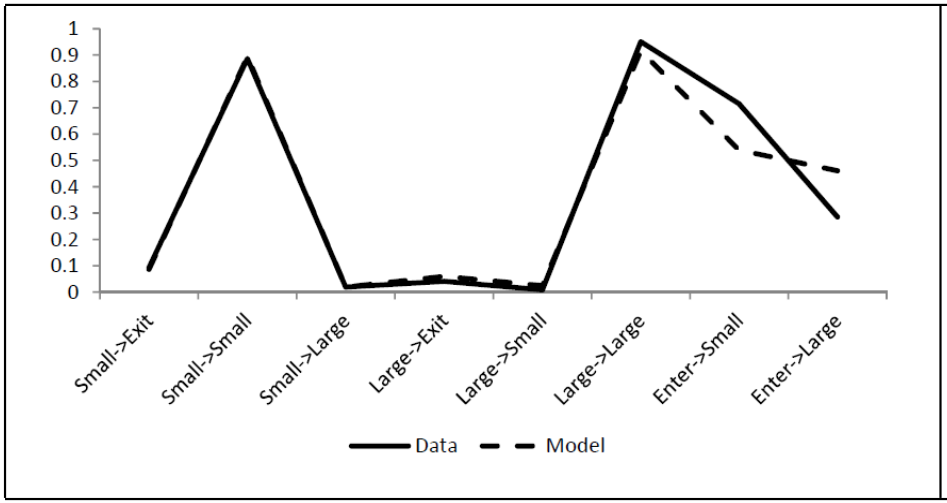
- High-type firms become low-type at the rate $\nu > 0$:

$$\theta^H \to \theta^L.$$

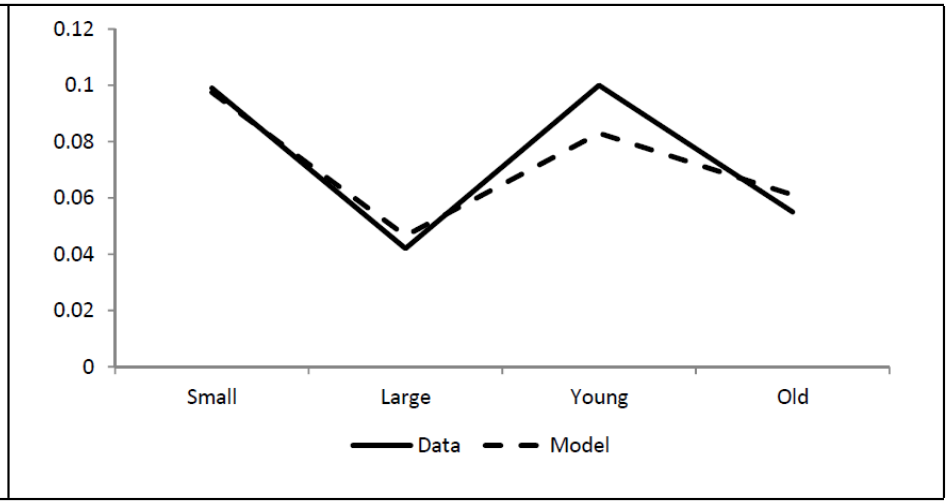
Data & Estimation

- Simulated Method of Moments estimation.
- We target 21 moments to estimate 12 parameters.
- Data Sources
  - Longitudinal Business Database (LBD)
  - Census of Manufacturers (CM)
  - NSF firm level R&D Survey
  - USPTO patent data matched to CM.
- Focus on "continuously innovative firms":
  - I.e., either R&D expenditures or patenting in the five-year window surrounding observation conditional on existence.
- 17,055 observations from 9835 firms.
- Accounts for 98% of industrial R&D.

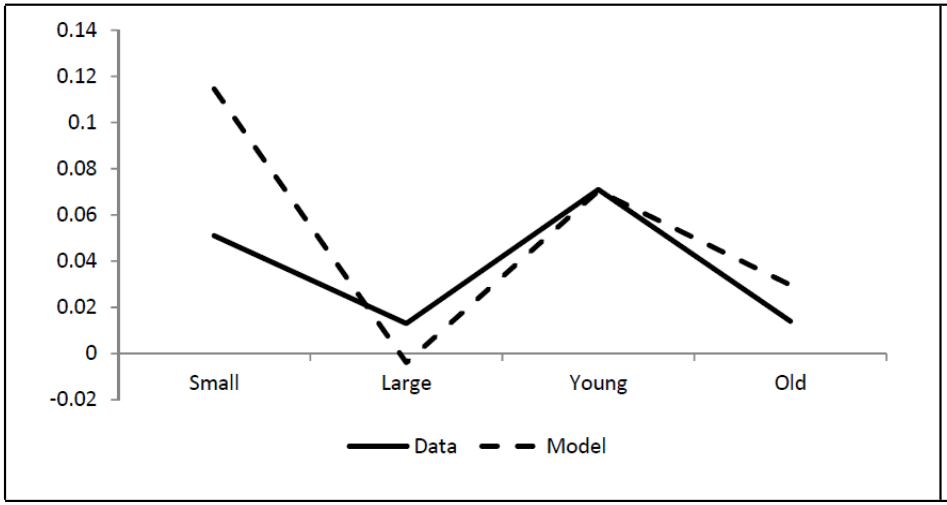
2A: Transition Rates



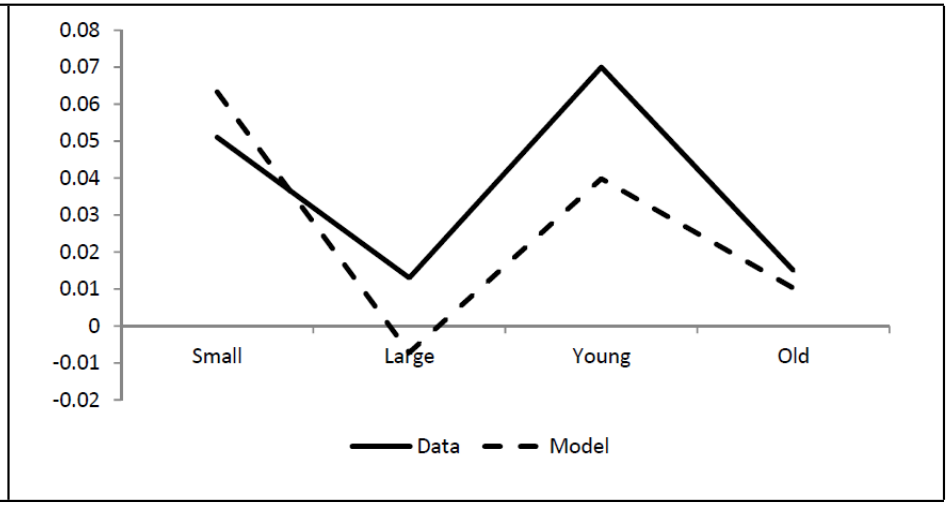
2B: R&D Intensity



2C: Sales Growth



2D: Employment Growth



20.	5-year Ent. Share	0.363	0.393		21.	Aggregate growth	0.022	0.022

We also do well on a range of non-targeted moments.

Policy Analysis: Subsidy to Incumbent R&D

TABLE 1. BASELINE MODEL

x^{entry}	x^l	x^h	m	Φ^l	Φ^h	$\hat{q}_{l,\min}$	$\hat{q}_{h,\min}$	g	Wel
8.46	2.80	9.58	73.6	71.16	24.53	13.90	0.00	2.24	100

- Use 1% to subsidize incumbents R&D.
- Compare steady states.

TABLE 2. INCUMBENT R&D SUBSIDY ($s_i = 15\%$)

x^{entry}	x^l	x^h	m	Φ^l	Φ^h	$\hat{q}_{l,\min}$	$\hat{q}_{h,\min}$	g	Wel
8.46	3.05	10.56	68.1	70.74	24.96	13.40	0.00	2.23	99.86

Notes: All numbers are in percentage terms.

Policy Analysis: Subsidy to the Operation of Incumbents

TABLE 1. BASELINE MODEL

x^{entry}	x^{l}	x^{h}	m	Φ^{l}	Φ^{h}	$\hat{q}_{l,\min}$	$\hat{q}_{h,\min}$	g	Wel
8.46	2.80	9.58	73.6	71.16	24.53	13.90	0.00	2.24	100

- Use 1% of GDP to subsidize operation costs of incumbents:

TABLE 3. OPERATION SUBSIDY ($s_o = 6\%$)

x^{entry}	x^{l}	x^{h}	m	Φ^{l}	Φ^{h}	$\hat{q}_{l,\min}$	$\hat{q}_{h,\min}$	g	Wel
8.46	2.80	9.59	73.7	71.30	24.52	11.74	0.00	2.22	99.82

- Now an important negative selection effect.

Restricted Optimal Policy

TABLE 1. BASELINE MODEL

x^{entry}	x^l	x^h	m	Φ^l	Φ^h	$\hat{q}_{l,\min}$	$\hat{q}_{h,\min}$	g	Wel
8.46	2.80	9.58	73.6	71.16	24.53	13.90	0.00	2.24	100

- Optimal mix of incumbent R&D subsidy and operation subsidy:

TABLE 4. OPTIMAL POLICY ANALYSIS AND WELFARE

INCUMBENT POLICIES ($s_i = 12\%, s_o = -264\%$)									
x^{entry}	x^l	x^h	m	Φ^l	Φ^h	$\hat{q}_{l,\min}$	$\hat{q}_{h,\min}$	g	Wel
8.46	3.04	10.21	75.3	62.31	25.53	91.38	54.85	3.11	104.6

Conclusion

- A new model of micro-level firm and innovation dynamics with reallocation.
- New features:
  - Endogenous exit;
  - Reallocation;
  - Selection effect.
- The model can be estimated and provides a good fit to the rich dynamics in US microdata.
- It is also useful for policy analysis.
  - Industrial policy directed at incumbents has small negative effects.
  - Optimal policy can substantially improve growth and welfare by taxing continued operation of incumbents leverage the selection effect.

Policy Analysis: Entry Subsidy and Selection

TABLE 1. BASELINE MODEL

x^{entry}	x^l	x^h	m	Φ^l	Φ^h	$\hat{q}_{l,\min}$	$\hat{q}_{h,\min}$	g	Wel
8.46	2.80	9.58	73.6	71.16	24.53	13.90	0.00	2.24	100

- Use 1% of GDP to subsidize entry:

TABLE 5. ENTRY SUBSIDY ($s_e = 5\%$)

x^{entry}	x^l	x^h	m	Φ^l	Φ^h	$\hat{q}_{l,\min}$	$\hat{q}_{h,\min}$	g	Wel
8.46	2.73	9.30	75.3	71.16	24.41	15.91	0.00	2.26	100.15