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, \( \phi \) in terms of skilled labor.

- Total cost
  
  \[ TC_{j,f} (y_{j,f}) = w^s \phi + \frac{w^u}{q_{j,f}} y_{j,f}. \]

- Define **relative productivity**:
  
  \[ \hat{q}_j \equiv \frac{q_j}{w^u}. \]
Definition of a Firm

A firm: collection of productivities and firm type

$$\text{Firm } f \equiv \{ q_{f1}^1, q_{f2}^2, ..., q_{fn}^n; \theta \}.$$ 

$n_f$ : number of product lines.
R&D and Innovation

- Innovation rate:
  \[ X_f = (n_f \theta_f)^\gamma h_f^{1-\gamma}. \]
  \[ h_f \text{ : number of researchers.} \]
- 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 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 $\phi$.

3. **Endogenous obsolescence.** Relative quality decreases due to the increase in the wage:

$$\hat{q} = \frac{q}{w^u}$$
Entry

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

- At the entry, each firm draws a management quality \( \theta \) :

\[
\theta = \begin{cases} 
\theta^H & \text{with probability } \alpha \\
\theta^L & \text{with probability } 1 - \alpha 
\end{cases}
\]

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

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

\[
\theta^H \rightarrow \theta^L.
\]
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.
We also do well on a range of non-targeted moments.
Policy Analysis: Subsidy to Incumbent R&D

Table 1. Baseline Model

<table>
<thead>
<tr>
<th>$x^{\text{entry}}$</th>
<th>$x^l$</th>
<th>$x^h$</th>
<th>$m$</th>
<th>$\Phi^l$</th>
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<td>2.80</td>
<td>9.58</td>
<td>73.6</td>
<td>71.16</td>
<td>24.53</td>
<td>13.90</td>
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<td>2.24</td>
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</tbody>
</table>

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

Table 2. Incumbent R&D Subsidy ($s_i = 15\%$)

<table>
<thead>
<tr>
<th>$x^{\text{entry}}$</th>
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Notes: All numbers are in percentage terms.
Policy Analysis: Subsidy to the Operation of Incumbents

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

Table 3. Operation Subsidy (s_o = 6%)

<table>
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- Now an important negative selection effect.
 Restricted Optimal Policy

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

### Table 4. Optimal Policy Analysis and Welfare

#### Incumbent Policies ($s_i = 12\%$, $s_o = -264\%$)

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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

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Use 1% of GDP to subsidize entry:

Table 5. Entry Subsidy ($s_e = 5\%$)

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