China’s Industrial Policy: An Empirical Evaluation

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China’s Rapid Expansion

These industries grew by 20-30 times during a 15-yr period.
China’s Industrial Policies

These expansions are partially fueled by China’s massive industrial policies

- National and regional five-year plans
- “Made in China 2025”: dominate industries of the future by 2025
  - Major push in 10 sectors, including robotics, aerospace and clean-energy cars
  - World leader in latest-generation ships and marine equipment

Low concentration, excess capacity, and regional “industry duplication”
Despite the importance of industrial policies, few welfare analyses exist.

We examine China’s industrial policy and the global shipbuilding industry:

- Quantify government support to domestic production, investment, and firm entry using a dynamic model.

And conduct counterfactual analysis:

- Benchmark effectiveness of different policies on revenue, profit, and welfare.
- Simulate industry evolution and welfare under alternative policies.
Summary of Findings

- **Magnitude of industrial policies large:**
  - Subsidy for production, investment, and entry is 159/51/330 bn RMB 2006-2013 (aggregate industry revenue 1700 bn RMB)
  - Boosted China’s investment by 270% and entry by 200%
  - Enhanced China’s world market share by 40%

- **Significant impact on world ship prices:**
  - 2006-08, reduction on price of bulk (8%), tanker (6%), and container (3%)
  - 2009-13, reduction on price of bulk (17%), tanker (11%), and container (4%)
  - Bigger impact in later periods due to increased capacity, num. of firms
Evaluation of different policies

- Effectiveness in boosting profit/revenue mixed: production and investment subsidies can be justified by output considerations; entry subsidies are wasteful
- Industry (discounted lifetime) profit increased by 145 bill RMB; subsidy ‘rate of return’ merely 18%
- Subsidy reduces HHI by 40% and lowers capacity utilization by 20%

Insights from this study:

- Distortions are convex and deteriorate with the magnitude of subsidies
- Dynamic sorting and targeting instrumental
- Timing (pro-cyclical vs. counter-cyclical) highly relevant
Industry Description and Facts
Model
Data and Empirical Strategy
Estimation results
Counterfactual analysis
Conclusion
(Chinese) Shipbuilding
History of Shipbuilding

- Shipbuilding a classic target and one of major subsidy recipients
- 1850s Britain; 1950s Japan; 1970s S. Korea; 2000s China
## Major Policies in China

### Table: Shipbuilding National Industrial Policies

<table>
<thead>
<tr>
<th>Year</th>
<th>Shipbuilding National Industrial Policies</th>
<th>Plan Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>2003</td>
<td>National Marine Economic Development Plan</td>
<td>2001-2010</td>
</tr>
<tr>
<td>2006</td>
<td><strong>The 11th Five-Year Plan for National Economic and Social Development</strong></td>
<td>2006-2010</td>
</tr>
<tr>
<td>2007</td>
<td>The 11th Five-Year Plan for the Development of Shipbuilding Industry</td>
<td>2006-2010</td>
</tr>
<tr>
<td>2007</td>
<td>The 11th Five-Year Plan for the Development of Shipbuilding Technology</td>
<td>2006-2010</td>
</tr>
<tr>
<td>2007</td>
<td>Shipbuilding Operation Standards</td>
<td>2007-</td>
</tr>
<tr>
<td>2009</td>
<td><strong>Plan on the Adjusting and Revitalizing the Shipbuilding Industry</strong></td>
<td>2009-2011</td>
</tr>
<tr>
<td>2010</td>
<td>The 12th Five-Year Plan for National Economic and Social Development</td>
<td>2011-2015</td>
</tr>
<tr>
<td>2013</td>
<td><strong>Shipbuilding Industry Standard and Conditions</strong></td>
<td>2013-</td>
</tr>
</tbody>
</table>
China’s Market Share Expansion

![Market Share Graph]

- **Market Share**
  - China
  - Japan
  - South Korea

- **X-axis**: Years from 1998 to 2014
- **Y-axis**: Market Share

- **Legend**:
  - Blue line: China
  - Green dashed line: Japan
  - Red dotted line: South Korea
Entry of New Shipyards

- China
- Japan
- South Korea
Capacity expansion is universal across firm age, ownership status, and geographical area.
Model
Model Overview

- Agents:
  - Chinese firms
  - Foreign firms (Japanese and S. Korean shipyards)

- Decisions:
  - Capital accumulation; entry and exit (dynamic)
  - Production (static)

- Products: $M$ ship types
  - Segregated markets
  - Ships homogeneous within a type
Chinese Industrial Policy

- Chinese central and regional government policies \((T_t)\) may provide:
  - **Production subsidies** that lower \(C(q_{jt})\)
    - input subsidy, export credits, preferential buyer financing
  - **Capital subsidies** that lower \(C^I(i_{jt})\)
    - low-interest credit, tax credits for accelerated capital depreciation
  - **Entry subsidies** that lower \(\kappa_{jt}\)
    - cheap land, simpler registration procedure

- A simple model of \(T_t\):
  - Two policy shocks (2006 and 2009)
  - They arrive unexpectedly and are considered permanent

- The transition process of payoff relevant variables (including prices) are assumed to satisfy the **Markovian** property pre- and post- policy intervention.
Model: Static Decisions

- Market demand for ships (omitting subscript on ship type):
  \[ Q^d_t = d_t - \eta P_t \]
  - \( d_t \) is “market size”, determined by world demand shifters, such as freight rates, commodity prices, total fleet

- Shipyard \( j \) solves (\( s_{jt} \) denotes cost shifters):
  \[
  \max_{q \geq 0} P_t q - C(q, s_{jt})
  \]
  which leads to profit
  \[ \pi(P_t, s_{jt}, q^*(P_t, s_{jt})) \]

- The market clears when total supply \( Q_t = \sum_j q^*(P_t, s_{jt}) \) equals demand
  \[ Q^d_t = d_t - \eta P_t \]
  - Equilibrium ship price \( P(s_t, d_t) \)
Model: Dynamic Decisions

- Each incumbent receives a random scrap value $\phi_{jt}$ and decides whether to exit.

- Shipyard $j$ with capital $k_{jt}$ invests $i_{jt}$ to accumulate capital:

$$k_{jt+1} = (1 - \delta)k_{jt} + i_{jt}$$

- Bellman equation ($s_{jt}$ includes all state variables):

$$V(s_{jt}, \phi_{jt}) = \pi(s_{jt}) + \max_{\chi_{jt}} \left\{ \max_{i_{jt}} \left( -C^{I}(i_{jt}, s_{jt}) + \beta E[V(s_{jt+1})|s_{jt}, i_{jt}] \right) \right\}$$

- Investment cost is $C^{I}(i_{jt}, s_{jt})$, inclusive of adjustment costs.

- Optimal policies:

$$\chi^*(s_{jt}, \phi_{jt}), i^*(s_{jt}), \text{ and similarly } \chi^{e*}(s_{jt}, \kappa_{jt})$$
Data
Data

- Clarksons (1998-2014):
  - Quarterly level data on prices $P_{mt}$
  - Orders received by type for each shipyard $q_{mjt}$
  - Characteristics for Japan and S. Korea shipyards


- Official documents on industrial policies (1998-2013)

- More than 10,000 firm-quarterly observations in total
Empirical Estimation
Empirical Estimation

- Primitives to recover:
  - Shipyard production costs:
    \( C(q_{jt}, T_t) \)
  - Investment cost:
    \( C^I(i_{jt}; T_t) \)
  - Distribution of entry and exit costs:
    \( \phi_{jt}, \kappa_{jt}(T_t) \)
  - Ship demand curves (for counter-factual analysis):
    \( P_m(d_{mt}, Q_{mt}^d) \)
Estimate Cost Function

The marginal cost of producing \( q_{jmt} \) equals:

\[
MC(q_{jmt}) = z_{jmt} \beta_m + \delta_m q_{jmt} + \omega_{jmt}
\]

- \( z_{jmt} \): capital, backlog, age, province, size, ownership, and subsidies
- Backlog captures economies of scale and learning
- \( \omega_{jmt} \): a cost (productivity) shock
- Firms are price takers. Largest firm’s market share < 5%.
- Results incorporating market power (via Cournot) are similar.

There are \( J_t^c \) Chinese firms and \( J_t^f \) foreign firms (in Japan and S. Korea)

- foreign firms’ marginal cost function similar \( MC_f(q_{jmt}) \)
## Production Cost Estimates

<table>
<thead>
<tr>
<th>Type-specific</th>
<th>Bulk</th>
<th>Tanker</th>
<th>Container</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coefficient</td>
<td>t-stat</td>
<td>Coefficient</td>
</tr>
<tr>
<td>MC (thousand RMB / CGT)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\beta_q$</td>
<td>7.34</td>
<td>9.52</td>
<td>13.60</td>
</tr>
<tr>
<td>$\sigma_\omega$</td>
<td>8.49</td>
<td>10.43</td>
<td>14.40</td>
</tr>
<tr>
<td>Constant (1000 RMB/CGT)</td>
<td>19.26</td>
<td>15.88</td>
<td>36.58</td>
</tr>
<tr>
<td>Steel price (1000 RMB/Ton)</td>
<td>1.55</td>
<td>7.49</td>
<td>1.10</td>
</tr>
<tr>
<td>Capital (bill RMB)</td>
<td>-2.43</td>
<td>-2.96</td>
<td>-2.61</td>
</tr>
<tr>
<td>Capital$^2$</td>
<td>0.19</td>
<td>0.83</td>
<td>0.06</td>
</tr>
<tr>
<td>Backlog</td>
<td>-1.56</td>
<td>-5.29</td>
<td>-4.44</td>
</tr>
<tr>
<td>Backlog$^2$</td>
<td>0.07</td>
<td>4.04</td>
<td>0.24</td>
</tr>
<tr>
<td>Backlog of other types</td>
<td>0.13</td>
<td>0.94</td>
<td>0.35</td>
</tr>
</tbody>
</table>

### Common

<table>
<thead>
<tr>
<th></th>
<th>Bulk</th>
<th>Tanker</th>
<th>Container</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006-2008</td>
<td>-1.51</td>
<td>-2.62</td>
<td></td>
</tr>
<tr>
<td>2009+</td>
<td>-1.38</td>
<td>-2.37</td>
<td></td>
</tr>
<tr>
<td>Large firms</td>
<td>-3.85</td>
<td>-6.97</td>
<td></td>
</tr>
<tr>
<td>Jiangsu</td>
<td>-2.64</td>
<td>-4.75</td>
<td></td>
</tr>
<tr>
<td>Zhejiang</td>
<td>-1.42</td>
<td>-2.80</td>
<td></td>
</tr>
<tr>
<td>Liaoning</td>
<td>-1.87</td>
<td>-2.05</td>
<td></td>
</tr>
<tr>
<td>CSSC/CSIC</td>
<td>-0.77</td>
<td>-1.20</td>
<td></td>
</tr>
<tr>
<td>Private</td>
<td>0.14</td>
<td>0.30</td>
<td></td>
</tr>
<tr>
<td>Foreign JV</td>
<td>-0.78</td>
<td>-1.45</td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>0.18</td>
<td>3.14</td>
<td></td>
</tr>
</tbody>
</table>

| N              | 4886          | 4977           | 2504            |
Cost Function Estimates

- $\delta$ suggests firms are responsive to prices:
  - Bulk / tanker / container production goes up by 21% / 28% / 22% with a 10% price increase
  - Convex cost: at $\bar{q}$, $\delta \cdot q$ accounts for 24-58% of a firm's marginal cost

- Larger capital associated with lower cost of production
  - Setting capital to 0 reduces profit by 38%

- Marginal cost decreases with backlog initially (economies of scale) and then increases (capacity constraints)
  - Increasing backlog by 100k CGT reduces marginal cost by 11-27%
Cost Function Estimates

- Production subsidy from 2006 to 2008 equals to 10-13% of the price
- MC for firms in Jiangsu/Liaoning/Zhejiang is lower by 18-22%, 13-16%, and 10-12%, respectively
- Fixed cost $c_0$ sizable (15% of profits)
- Results robust across alternative specifications
  - pooling across countries
  - drop new shipyards
  - firm- and industry-level learning by doing
- Limited evidence of industry-wide spillovers
Empirical Estimation

- Primitives to recover:
  - Shipyard production costs:
    \[ C(q_{jt}, T_t) \]
  - Investment cost:
    \[ C^I(i_{jt}; T_t) \]
  - Distribution of entry and exit costs:
    \[ \phi_{jt}, \kappa_{jt}(T_t) \]
  - Ship demand curves (for counter-factual analysis):
    \[ P_m(d_{mt}, Q^d_{mt}) \]
The Bellman equation for incumbents is:

\[ V(s_{jt}, \phi_{jt}) = \pi_{jt} + \max_{\chi_{jt}} \{ \phi_{jt}, CV(s_{jt}) \} \]

Assume \( \phi_{jt} \sim F_{\phi}(\sigma) \) (exponential), ex-ante value fn is:

\[
V(s_{jt}) = \pi_{jt} + p^x \sigma + CV(s_{jt}) \\
CV(s_{jt}) = E_{\nu_{jt}} \left\{ \max_{i_{jt}} [-C^I(i_{jt}, \nu_{jt}) + \beta E[V(s_{jt+1})|s_{jt}, i_{jt}]] \right\}
\]

Cost of investment:

\[ C^I(i_{jt}, \nu_{jt}) = c_1 i_{jt} + c_2 v_{jt} i_{jt} + c_3 i_{jt}^2 + c_4 T t i_{jt} \]

- Random investment shocks \( \nu_{jt} \)
- Quadratic adjustment costs \( (c_3) \).
- Investment subsidy \( (c_4) \)
- Other types of adjustment costs \( \frac{i_{jt}^2}{k} \), random fixed costs, irreversibility) insignificant
Investment Cost Estimates

\[ C^I(i_{jt}, \nu_{jt}) = c_1 i_{jt} + c_2 \nu_{jt} i_{jt} + c_3 i_{jt}^2 + c_4 T_t i_{jt} \]

<table>
<thead>
<tr>
<th></th>
<th>Coeff.</th>
<th>t-stat</th>
</tr>
</thead>
<tbody>
<tr>
<td>(c_1)</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>(c_2)</td>
<td>1.55</td>
<td>8.27</td>
</tr>
<tr>
<td>(c_3)</td>
<td>21.72</td>
<td>10.57</td>
</tr>
<tr>
<td>(c_4)</td>
<td>-0.25</td>
<td>-1.89</td>
</tr>
<tr>
<td>(c_4) Post 2009</td>
<td>-0.49</td>
<td>-4.07</td>
</tr>
</tbody>
</table>

- Standard errors from 500 block bootstrap simulations
- Importance of \(\nu_{jt}\)
- Quadratic adj. costs: 28% of investment costs; > 50% for large investments (> 50mill)
- Proportion of investment costs subsidized high
# Entry Cost Estimates

<table>
<thead>
<tr>
<th>Region</th>
<th>$\kappa_{pre}$</th>
<th>$\kappa_{06-08}$</th>
<th>% of pre-06 cost</th>
<th>$\kappa_{09+}$</th>
<th>% of pre-2006 costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jiangsu</td>
<td>60</td>
<td>22</td>
<td>36%</td>
<td>69</td>
<td>114%</td>
</tr>
<tr>
<td>Zhejiang</td>
<td>91</td>
<td>37</td>
<td>41%</td>
<td>194</td>
<td>214%</td>
</tr>
<tr>
<td>Liaoning</td>
<td>56</td>
<td>29</td>
<td>51%</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Other</td>
<td>25</td>
<td>10</td>
<td>38%</td>
<td>44</td>
<td>172%</td>
</tr>
</tbody>
</table>

- $\kappa_{jt}(T_t)$ (exponentially distributed) differs across regions and policy regimes
- Subsidies during 06-08 reduced entry costs by 50-60%, robust to $\bar{N}_e$
- Mean entry cost paid per entrant is 2.3 bn RMB; close to accounting estimates
- Mean of the scrap value distribution is 0.69 bill RMB, t-stat 11.8
Primitives to recover:

- Shipyard production costs:
  \[ C(q_{jt}, T_t) \]

- Investment cost:
  \[ C^I(i_{jt}; T_t) \]

- Distribution of entry and exit costs:
  \[ \phi_{jt}, \kappa_{jt}(T_t) \]

- Ship demand curves (for counter-factual analysis):
  \[ P_m \left( d_{mt}, Q_{mt}^d \right) \]
Evaluation of China’s Industrial Policy
From 2006-2013, 148 firms enter with subsidies vs. 65 without

Subsidies depress number of exits (37 vs. 46) and change distribution of exiting firms: fewer incumbents exit but more entrants exit in downturn
Total investment during 2006-2013 is 114 bill RMB with subsidies vs. 42 bill RMB without subsidies
HHI is 40% lower with subsidies in 2009-2013 (more fragmentation)

\( Q/K \) is 20% lower with subsidies in 2009-2013
### Impact on World Prices

**Table: Impact of Subsidy on World Price**

<table>
<thead>
<tr>
<th></th>
<th>Bulk</th>
<th>Tanker</th>
<th>Container</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subsidies, 2006-08</td>
<td>16.3</td>
<td>20.0</td>
<td>17.2</td>
</tr>
<tr>
<td>No subsidies, 2006-08</td>
<td>17.6</td>
<td>21.2</td>
<td>17.7</td>
</tr>
<tr>
<td>% difference</td>
<td>8.2%</td>
<td>6.2%</td>
<td>3.1%</td>
</tr>
<tr>
<td>Subsidies, 2009-13</td>
<td>8.8</td>
<td>8.1</td>
<td>9.2</td>
</tr>
<tr>
<td>No subsidies, 2009-13</td>
<td>10.2</td>
<td>9.0</td>
<td>9.5</td>
</tr>
<tr>
<td>% difference</td>
<td>16.5%</td>
<td>10.6%</td>
<td>3.7%</td>
</tr>
</tbody>
</table>

*Note: Prices in 1000 RMB/CGT*

- Magnitude depends on supply and demand elasticity
  - Demand for containers more elastic hence effect smaller
- Effect larger in later period due to increased capacity and larger num. of firms
Impact on the World Industry

- Subsidies increased China's market share by 40%
  - China stole roughly equal market share from Japan and S. Korea
  - Profits by Japanese and South Korean shipyards reduce by 140 bn RMB
- Worldwide shippers benefit by 230 bill RMB
  - China accounts for less than 10% of world shippers
Subsidy Comparison

- How effective are these policies in generating profit and/or revenue?

- Production subsidy is static, while investment and entry subsidies have dynamic consequences
  - More investment and entry today imply more production and higher profit tomorrow

- Simulate long-run industry equilibrium from 2006-2099 (discounted profit post 2099 negligible)
  - Turning on and off subsidies as needed
  - Equilibrium prices are determined by supply and demand
### Subsidy Comparison

**Table: Comparison of Different Subsidies: Bill RMB**

<table>
<thead>
<tr>
<th></th>
<th>All Subsidies</th>
<th>Only Production</th>
<th>Only Investment</th>
<th>Only Entry</th>
<th>No Subsidies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lifetime Revenue 2006-2099</td>
<td>2320</td>
<td>2091</td>
<td>1796</td>
<td>1830</td>
<td>1696</td>
</tr>
<tr>
<td>Lifetime Profits 2006-2099</td>
<td>854</td>
<td>788</td>
<td>618</td>
<td>590</td>
<td>570</td>
</tr>
<tr>
<td>Production Subsidies</td>
<td>256</td>
<td>216</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Investment Subsidies</td>
<td>86</td>
<td>0</td>
<td>44</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Entry Subsidies</td>
<td>302</td>
<td>0</td>
<td>0</td>
<td>171</td>
<td>0</td>
</tr>
<tr>
<td><strong>Δ Revenue/Subsidy</strong></td>
<td>97%</td>
<td>183%</td>
<td>226%</td>
<td>78%</td>
<td></td>
</tr>
<tr>
<td><strong>Δ (Profit-Inv. Cost)/Subsidy</strong></td>
<td>44%</td>
<td>93%</td>
<td>148%</td>
<td>11%</td>
<td></td>
</tr>
<tr>
<td><strong>Δ Net Profit/Subsidy</strong></td>
<td>18%</td>
<td>56%</td>
<td>87%</td>
<td>24%</td>
<td></td>
</tr>
</tbody>
</table>

- Net Profit = (Profits-Investment Cost + Scrap Value - Entry Cost)
- Entry subsidies from 2006 to 2008 while production and investment subsidies from 2006 to 2099
Production and investment subsidies can be justified by output considerations.

Entry subsidies attract high-cost firms and are wasteful.

Aggregate return to subsidies merely 18%.

Subsidies lead to higher aggregate fixed costs incurred, which augment inefficiency.

- Absent fixed costs, rate of return would increase from 18% to 29%.

Convexity: subsidies much more distortionary when combined.
**Comparing Production and Investment Subsidies**

**Table**: Production vs. Investment Subsidies: Bill RMB

<table>
<thead>
<tr>
<th></th>
<th>100% Production subsidies</th>
<th>50% Production subsidies</th>
<th>Investment subsidies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lifetime Revenue 2006-</td>
<td>2104</td>
<td>1937</td>
<td>1851</td>
</tr>
<tr>
<td>Lifetime Profits 2006-</td>
<td>783</td>
<td>682</td>
<td>641</td>
</tr>
<tr>
<td>Production subsidies</td>
<td>219</td>
<td>97</td>
<td>0</td>
</tr>
<tr>
<td>Investment subsidies</td>
<td>0</td>
<td>0</td>
<td>93</td>
</tr>
<tr>
<td>Entry subsidies</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>$\Delta$ Revenue/Subsidies</td>
<td>161%</td>
<td>192%</td>
<td>106%</td>
</tr>
<tr>
<td>$\Delta$ (Profit-Invest Cost)/Subsidies</td>
<td>82%</td>
<td>93%</td>
<td>98%</td>
</tr>
<tr>
<td>$\Delta$ Net Profit/Subsidies</td>
<td>51%</td>
<td>62%</td>
<td>82%</td>
</tr>
</tbody>
</table>

- The larger the magnitude of subsidies, the lower the per-unit return
- Investment subsidies lead to higher industry net profits
- Production subsidies more effective instrument for achieving output/revenue targets
Targeting

Table: Subsidizing Efficient vs. Inefficient Firms: Bill RMB

<table>
<thead>
<tr>
<th></th>
<th>Inefficient Firms</th>
<th>Efficient Firms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lifetime Revenue 2006-2099</td>
<td>406</td>
<td>1911</td>
</tr>
<tr>
<td>Lifetime Profits 2006-2099</td>
<td>70</td>
<td>779</td>
</tr>
<tr>
<td>Production Subsidies</td>
<td>40</td>
<td>215</td>
</tr>
<tr>
<td>Investment Subsidies</td>
<td>26</td>
<td>60</td>
</tr>
<tr>
<td>Entry Subsidies</td>
<td>157</td>
<td>146</td>
</tr>
<tr>
<td>(\Delta) Revenue/Subsidies</td>
<td>71%</td>
<td>113%</td>
</tr>
<tr>
<td>(\Delta) (Profit-Invest Cost)/Subsidies</td>
<td>19%</td>
<td>58%</td>
</tr>
<tr>
<td>(\Delta) Net Profit/Subsidies</td>
<td>-4%</td>
<td>29%</td>
</tr>
</tbody>
</table>

- Subsidizing efficient firms based on initial attributes more effective
  - Efficient firms less likely distorted in all margins: entry, production, investment, exit
  - Efficient firms benefit more from economies of scale: backlog and capital
- Entry subsidies particularly poorly targeted: over 50% go to low-profit firms
Business Cycle

### Table: Pro-Cyclical vs. Counter-Cyclical Industrial Policy: Bill RMB

<table>
<thead>
<tr>
<th></th>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>Lifetime Revenue 2006-2099</td>
<td>1792</td>
<td>1795</td>
</tr>
<tr>
<td>Lifetime Profits 2006-2099</td>
<td>609</td>
<td>624</td>
</tr>
<tr>
<td>Production Subsidies</td>
<td>34</td>
<td>35</td>
</tr>
<tr>
<td>Investment Subsidies</td>
<td>16</td>
<td>16</td>
</tr>
<tr>
<td>$\Delta$ Revenue/Subsidies</td>
<td>222%</td>
<td>225%</td>
</tr>
<tr>
<td>$\Delta$ (Profit-Invest Cost)/Subsidies</td>
<td>86%</td>
<td>126%</td>
</tr>
<tr>
<td>$\Delta$ Net Profit/Subsidies</td>
<td>29%</td>
<td>78%</td>
</tr>
</tbody>
</table>

- Timing important: counter-cyclical policies out-perform pro-cyclical policies
  - expansion more costly during boom; firm composition different
- Actual policy mix is pro-cyclical: 442 bn of subsidies during boom, 106 bn during recession
Subsidizing during recession selects more efficient firms over the long run

- Through more efficient entry and exit
Discussion

Traditional rationale of industrial policies:

- Marshallian externality
  - No evidence of industry wide learning-by-doing
- Strategic trade considerations
  - Market power negligible
- Spillover to other sectors and the labor market
  - Shipbuilding a small component of steel demand and total employment
  - Input-Output table suggests little spillover to other sectors
  - China is not a big player in international transportation service
- Impact on trade volume
  - Could be considerable but welfare benefit difficult to quantify
- Military (national security) considerations and the desire to be world no. 1
  - We provide cost estimates for achieving these objectives
Conclusion

- Massive (and wasteful) subsidies for the shipbuilding industry 2006-2013
  - China’s world market share increased by 40%
  - At the cost of low concentration and capital utilization

- Effectiveness of the policies mixed:
  - Prod/inv subsidies could be justified by market share considerations
  - Entry subsidies are wasteful and increase fragmentation and idleness cost
  - Prod subsidy better at raising revenue; inv subsidy delivering a higher return

- Broad lessons:
  - Distortions are convex and deteriorate with the magnitude of subsidies
  - Dynamic sorting and targeting instrumental
  - Timing (pro-cyclical vs. counter-cyclical) highly relevant
Thanks and Comments Welcome!
Appendix
Capital Expansion
Capital Expansion of Existing Firms

![Graph showing capital expansion of existing firms from 1998 to 2014. The graph compares incumbent firms and post-2006 entrants.](image-url)
$J^e$ potential entrants. Each with a random entry cost $\kappa_{jt}$

Value function

$$VE(s_{jt}, \kappa_{jt}) = \max_{\chi^e_{jt}} \left\{ \begin{array}{c} -C^I(K_{jt}) + \beta E \left[ V(s_{jt+1}) | s_{jt}, \chi^e_{jt} = 1 \right] \end{array} \right.$$

Optimal entry policy

$$\chi^{e*}(s_{jt}, \kappa_{jt})$$
Estimate Cost Function: Alternative Approach

- One approach is to back out the cost function using the estimated production function (OP/LP)
  \[ q_{jt} = f(k_{jt}, l_{jt}, m_{jt}, \omega_{jt}) \]

- Construct \( C_{jt} = \text{labor costs} + \text{material costs} + \text{capital costs associated with quantity } q_{jt} \)

- Challenge: data quality low
  - Reported costs unreliable
  - No inputs after 2007, etc.
### Production Cost: Other Specifications

|                      | Baseline |  |  | Existing yards |  |  |
|----------------------|----------|  |  |                |  |  |
|                      | (1) Coeff. | t-stat | (2) Coeff. | t-stat | (3) Coeff. | t-stat | (4) Coeff. | t-stat |
| **Bulk**             |          |        |            |        |            |        |            |        |
| Capital              | -2.92    | -3.06  | -2.91      | -3.11  | -3.33      | -3.18  | -1.94      | -2.12  |
| Backlog              | -2.09    | -6.63  | -2.09      | -6.41  | -3.16      | -6.38  | -1.45      | -5.05  |
| Cumul. Q.            |          |        |            |        |            |        | 0.07       | 4.72   |
| **Tanker**           |          |        |            |        |            |        |            |        |
| Capital              | -2.06    | -1.55  | -2.06      | -1.56  | -2.49      | -1.41  | -1.95      | -1.52  |
| Backlog              | -4.50    | -6.38  | -4.50      | -6.42  | -5.15      | -6.13  | -4.41      | -5.06  |
| Cumul. Q.            |          |        |            |        |            |        | 0.09       | 5.59   |
| **Container**        |          |        |            |        |            |        |            |        |
| Capital              | -1.41    | -1.33  | -1.41      | -1.33  | -0.44      | -0.40  | -1.11      | -1.22  |
| Backlog              | -3.06    | -4.40  | -3.06      | -4.40  | -3.66      | -4.25  | -0.90      | -1.30  |
| Cumul. Q.            |          |        |            |        |            |        | 0.01       | 4.00   |
| **Common**           |          |        |            |        |            |        |            |        |
| China 2006-2008      | -2.79    | -4.57  | -2.78      | -4.19  | -2.08      | -2.72  | -2.43      | -4.43  |
| China 2009+          | -0.90    | -1.56  | -0.89      | -1.35  | -1.01      | -1.25  | -0.95      | -1.73  |
| Trend                | -0.02    | -0.03  |           |        |            |        |            |        |