The Persistence of Differences in Productivity, Wages, Skill Mixes and Profits Between Firms in a Rapidly Changing Environment

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Evidence

Persistent difference:

1. Productivity: Baily, Hulten and Campbell (1992)
2. Wage payments and skill mix: Haltiwanger, Lane, and Spletzer (2000)

Positive Correlation:

1. Productivity, skill and wage payments are positively correlated: Haltiwanger, el. (1999)
2. Skill and profits are positively correlated: Abowd, el. (2004)
Assignment model [e.g., Sattinger (1993)]...If a firm specific resource and skill of workers are complementary to each other, the assignment is positive assortative.

Questions:

1. Why do some firms succeed in investing and maintaining their specific resources while others do not?
   – Rapid job creation and job destruction [e.g., Davis and Haltiwanger (1999)].

2. Can the assignment model provide a reasonable explanation even if we cannot observe firm-specific resources?
   – Unobserved heterogeneity explains a large part of the variations in productivity [e.g., Bartelsman and Doms (2000)].
     ⇒ Assignment based on intangible assets must rely on perceived values.
     ⇒ Speculative beliefs can influence the persistence of variables.
This Paper: This paper constructs a dynamic assignment model between unobserved O.C. and skill.

Organization Capital...All types of intangible assets embodied in an organization - organizational structure, daily practice, routine, corporate culture and so on.

Three main assumptions:
1. Skill and O.C. are complement.
2. Skill is needed for the accumulation of O.C.
3. O.C. is inferred from output.
The Main Logic:
Assignment between belief and skill
⇒ High belief attracts skilled workers
⇒ Skilled workers create more O.C.
⇒ Large O.C. is likely to yield large output.
⇒ Large output creates high belief.

• This persistence is induced by two positive feedback mechanisms:
  (a) Feedback between the accumulation of O.C. and the employment of skilled workers
  (b) Feedback between the fundamental capability of a firm and the beliefs about the capability.
Main Results:

1. Theory: two sources of persistence.
   (a) The heterogeneity of skills
   (b) The difficulty of measuring organization capital.

2. Evidence: a model can quantitatively account for observed persistence.
   (a) If no diversity in skill, the relative advantages would disappear in 4-6 years.
   (b) An improved information does not change persistence very much.
The correlation between current relative productivity and past relative productivity
(small sample)

The correlation between current relative productivity and past relative productivity
(large sample)
The correlation between current relative wages and past relative wages

(small sample)

The correlation between current relative wages and past relative wages

(large sample)
The correlation between current relative profits per worker and past relative profits per worker

- Small sample:
  - Data: relative profits per worker
  - Model (estimation 1): expected relative profits per worker
  - Model (estimation 2): expected relative profits per worker

- Large sample:
  - Data: relative profits per worker
  - Model (estimation 1): expected relative profits per worker
  - Model (estimation 2): expected relative profits per worker
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The autocorrelation without skill variation: productivity (small sample)

The autocorrelation without skill variation: productivity (large sample)
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The correlation between relative productivity and relative wages.

<table>
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<th>Small Estimation 1</th>
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<th>Large Estimation 1</th>
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Model

Environment

- $k_t^o$...organization capital
  - $\ln k_t^o \sim N(\mu_{kt}, \sigma_{kt}^2)$
- A firm consists of organization capital and a set of jobs.
- Total mass of jobs is normalized to be 1.
- $q_t$...the quality of skill
  - $\ln q_t \sim N(\mu_q, \sigma_q^2)$
- Firms and Works have reservation values of 0
- The population of firms and that of workers are 1.
Production Function at ith Job

\[ y_{it} = e^{u_t} A (k_t^o)^\alpha q_{it}^\psi, \ u_t \sim N \left( -\frac{\sigma_u^2}{2}, \sigma_u^2 \right) \]

Expected Output:

\[ E \left[ y_{it} | \mu_{kt}, \ln q_{it} \right] = \exp \left( \ln A + \alpha \mu_{kt} + \frac{\alpha^2 \sigma_{kt}^2}{2} + \psi \ln q_{it} \right). \]

Aggregate State Variables: \((\mu_{kt}^e, \sigma_{\mu t}, \sigma_{kt})\)
- \(\sigma_{kt}\) identical
- \(\mu_{kt} \sim N \left( \mu_{kt}^e, \sigma_{\mu t}^2 \right)\)
Profit Max.

\[
\hat{\chi}_i(\mu_{kt}) = \arg \max_{\ln q_{it}} \{E[y_{it}|\mu_{kt}, \ln q_{it}] - \hat{w}(\ln q_{it})\}, \forall i,
\]

Labor Market Clearing Condition:

\[
1 - \Phi \left( \frac{\mu_{kt} - \mu_{kt}^e}{\sigma_{\mu t}} \right) = 1 - \Phi \left( \frac{\hat{\chi}_i(\mu_{kt}) - \mu_q}{\sigma_q} \right), \forall \mu_{kt}.
\]

Definition: A market equilibrium consists of \(\hat{\chi}_i(\mu_{kt})\) and \(\hat{w}(\ln q_t)\) that satisfy above two equations.
Theorem 1  A unique market equilibrium exists.

Proposition 1  Skill, wage and expected profits are an increasing function of $\mu_{kt}$. Labor productivity is an increasing function of $\mu_{kt}$ and $k_t^0$. 
Dynamics of $\ln k^o_t$:

\[
\ln k^o_{t+1} = \ln B + \phi \ln (k^o_t) + \gamma \ln q^e_t + \varepsilon_t, \quad q^e_t = \int_0^1 q_{it} dt, \quad \varepsilon_t \sim N \left( -\frac{\sigma^2_\varepsilon}{2}, \sigma^2_\varepsilon \right)
\]

\[
= \ln B + \phi \ln k^o_t + \gamma \hat{\chi}_i (\mu_{kt}) + \varepsilon_t
\]

Information Structure: As the firm knows $e^{u_t} (k^o_t)^\alpha$:

\[
s_t \equiv \ln k^o_t + u^*_t, \quad u^*_t = \frac{1}{\alpha} \left( u_t + \frac{\sigma^2_u}{2} \right)
\]

Dynamics of $\mu_{kt}$

\[
\mu_{kt+1} = \ln B + \phi \left[ (1 - h_t) \mu_{kt} + h_t s_t \right] + \gamma \hat{\chi}_i (\mu_{kt}) - \frac{\sigma^2_\varepsilon}{2}, \quad h_t = \frac{\left( \frac{\alpha \sigma_{kt}}{\sigma_u} \right)^2}{1 + \left( \frac{\alpha \sigma_{kt}}{\sigma_u} \right)^2}
\]
Proposition 2 The aggregate economy converges to a unique stationary distribution. Moreover, a firm dynamics follows the VAR of $\ln k^o_t$ and $\mu_{kt}$.

Proposition 3 Suppose that $\phi \in (0, 1)$, and that $\frac{\sigma_u}{\alpha \sigma_\varepsilon}$ and $\frac{\gamma \sigma_q}{\sigma_\varepsilon}$ are finite. The VAR of $\ln k^o_t$ and $\mu_{kt}$ is covariance stationary.

Proposition 4 A decrease in $h_\infty$ (= an increase in $\frac{\sigma_u}{\alpha \sigma_\varepsilon}$) or an increase in $\frac{\gamma \sigma_q}{\sigma_\varepsilon}$

1. immediately increases the autocorrelation of $\mu_{kt}$.
2. eventually increases the autocorrelation of $\ln k^o_t$. 
**Structural Estimation:** Using COMPUSTAT industry annual data set in 1970-2004, the paper identifies structural parameters: $\phi$, $\gamma\sigma_q$, and $h_\infty$.

**Estimation Method:** Read Paper

**Results:**
- The estimated parameters are all significant and their signs are consistent with theoretical predictions.
- Two-year lagged relative wages have a positive impact on current relative productivity after controlling for one- and two-year lags of relative productivity.
- Perceived relative productivity, which is constructed by using sequences of past relative productivity, has a positive impact on future relative productivity.
Conclusions:

1. Theory: two sources of persistence.
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2. Evidence: a model can quantitatively account for observed persistence.
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