Changing the Boundaries of the Firm: Changes in the Clustering of Human Capital
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This document reports the results of research and analysis undertaken by the U.S. Census Bureau staff. It has undergone a Census Bureau review more limited in scope than that given to official Census Bureau publications, and is released to inform interested parties of ongoing research and to encourage discussion of work in progress. This research is a part of the U.S. Census Bureau’s Longitudinal Employer-Household Dynamics Program (LEHD), which is partially supported by the National Science Foundation Grant SES-9978093 to Cornell University (Cornell Institute for Social and Economic Research), the National Institute on Aging, and the Alfred P. Sloan Foundation. The views expressed herein are attributable only to the author(s) and do not represent the views of the U.S. Census Bureau, its program sponsors or data providers. Some or all of the data used in this paper are confidential data from the LEHD Program. The U.S. Census Bureau is preparing to support external researchers’ use of these data; please contact Ronald Prevost (Ronald.C.Prevost@census.gov), U.S. Census Bureau, LEHD Project, FB 2138-3, 4700 Silver Hill Rd., Suitland, MD 20233, USA.
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• Any opinions, findings, and conclusions or recommendations expressed in this publication are those of the authors and do not necessarily reflect the views of the U.S. Census Bureau, Cornell University, or the National Science Foundation.

• Confidential data from the LEHD Program were used in this paper. The U.S. Census Bureau is preparing to support external researchers’ use of these data under a protocol to be released in the near future. For further information, contact Ronald C. Prevost LEHD Program Director (ronald.c.prevost@census.gov).
Motivation

- Distinguish among similar businesses using the human capital of the employees
- Normal measures: employment and wages, sometimes hours
- Our measures: a variety of skill indices based on the portable part of the individual's wage rate
- Use the differences in the human capital input to help explain differences in the outcomes
Theoretical Framework

- The general human capital of an employee is represented by $s$.
- $Z$ is the firm-specific part of the wage rate, used to model compensation design issues.
- $S$ can be a vector but we use scalars in this work.
- The un-normalized distribution $f(s)$ measures the firm's human capital choices.
- Then, conventional employment, $L$, and total payroll, $W$, are as shown.
- Output is a functional of $f(s)$.

$$Q = Q(f(s), K, z)$$

$$L = \int f(s)\,ds$$

$$W = \int w(s + z) f(s)\,ds$$
Optimization

\[ \pi = pQ - W \]

\[ \frac{\partial \pi}{\partial f(s_0)} = 0 = p \frac{\partial Q}{\partial f(s_0)} - w(s_0 + z) \]

\[ \forall s_0 \in [s, \bar{s}] \]

• The demand for human capital is determined by solving the profit maximization problem for the function \( f(s) \).
The Distribution of s

- Human capital $s$ is a scalar on a finite interval.
- The normalized density $g(s)$ summarizes the distribution of human capital within the business.
- We use a nonparametric estimator of $g(s)$.

\[
F(s) = \int_{s}^{\bar{s}} f(s) \, ds, \quad s \in [s, \bar{s}]
\]

\[
L = F(\bar{S})
\]

\[
G(s) = \frac{F(s)}{L}
\]

\[
g(s) = \frac{f(s)}{L}
\]
Measurement of Human Capital

\[ \ln w_{it} = \theta_i + x_{it} \beta + \psi J(i,t) + \epsilon_{it} \]

- We use a decomposition of the log real annualized full-time, full-year wage rate (\( \ln w \)) into person and firm effects.
- The person effect is \( \theta \).
- The firm effect is \( \psi \), where \( J(i,t) \) is the employer of \( i \) at \( t \).
- Continuous, time-varying effects are in \( x \beta \), where some of the \( x \) variables are human capital measures (labor force experience) and some correct for differential quality in our measure of full-time, full-year wage rate.
Measurement of Human Capital

\[ \hat{s}_{it} = \hat{\theta}_i + \text{labor force experience part of } x_{it} \hat{\beta} \]

• Individual human capital, \( s \), is the part associated with the person effect and the measurable time-varying personal characteristics (labor force experience).

• Alternatively, we can use \( \theta \) directly.

• We can also decompose \( \theta \) into the unobservable part and the part due to education and sex.
Data

- LEHD Program’s Employment Dynamics Estimates project and the Economic Censuses.
- Work history: quarterly UI earnings reports for all employees.
- Firm: UI-account based measure of firm links to ES-202 quarterly employer reports.
- Firm: EIN based links to Economic Censuses (1992, 1997) and
- Data are also available for Minnesota, Texas, North Carolina, Pennsylvania, and New Jersey to be added during 2002.
- Coverage: 60% of US work force when all 9 states have been processed
Creation of the Dependent Variable

• Full-time equivalent annualized wage rate
• Annualized wage rate is created from the quarterly wage rates by considering all possible quarterly histories and computing the expected annual earning conditional on the individual’s work history
• Full-time status is multiply-imputed using variable common to the work history and the Current Population Survey
Estimation of $s$

- Decomposition of the log real annualized full-time, full-year wage rate ($\ln w$) into person and firm effects.
- $S$ is the part associated with the person effect and the measurable personal characteristics (labor force experience, education).
- $Z$ is the firm effect.
- Our human capital measure is not a simple ranking by wage rate.

\[
\ln w_{ijt} = \theta_i + x_{it} \beta + \psi_j + \varepsilon_{ijt}
\]
\[
\hat{s}_{ijt} = \hat{\theta}_i + x_{it} \hat{\beta}
\]
\[
\hat{\psi}_j = \hat{\psi}_j
\]
<table>
<thead>
<tr>
<th>Component</th>
<th>Standard Deviation</th>
<th>Correlation with</th>
</tr>
</thead>
<tbody>
<tr>
<td>Log real annual wage rate (ln ( w ))</td>
<td>0.895</td>
<td>1.000</td>
</tr>
<tr>
<td>Person effect (( \theta ))</td>
<td>0.827</td>
<td>0.498</td>
</tr>
<tr>
<td>Firm effect (( \psi ))</td>
<td>0.361</td>
<td>0.045</td>
</tr>
<tr>
<td>Time-varying personal characteristics (( x\beta ))</td>
<td>0.672</td>
<td>-0.591</td>
</tr>
<tr>
<td>Residual (( \epsilon ))</td>
<td>0.365</td>
<td>0.000</td>
</tr>
</tbody>
</table>


Sources: Authors' calculations using the LEHD Program Employment Dynamics Estimates data base.
Estimation of $g_{jt}(s)$

- Use a kernel density estimator applied to all individuals working for firm $j$ as of the end of the first quarter of 1992 and 1997.
- Apply a Bayesian prior to get a posterior estimated density that is strictly positive over the full range of $s$.
- Use the posterior estimate of $g_{jt}(s)$ to compute the CDF $G_{jt}(s)$. 
Estimation of Firm’s Human Capital Summary Measures

• Compute deciles of $s$ for entire population in 1992:1.

• Use these deciles, $B_1, \ldots, B_{10}$, as fixed boundaries for summarizing the firm’s use of $s$ in 1992 and 1997, allowing for meaningful change measures.

• Compute

$$\hat{G}_{jt}(B_{k-1}) - \hat{G}_{jt}(B_k)$$

• for $k=1, \ldots, 10$ and $t = 1992, 1997$. 
Results

• Charts for Manufacturing, Retail Trade and FIRE (all 1992 and 1997 SICs are covered)
• All 1992, 1997 active
• Exiters (present in 1992, gone in 1997)
• Entrants (present in 1997, not in 1992)
• Continuers (present in both 1992, 1997)
1992 and 1997 S Distribution

Density vs. s0

PLOT
- 1992 s
- 1997 s
Distribution of Human Capital (s) for Manufacturing 1992, Exiters

Decile of the Skill Distribution

Percentage of Employment

All Sectors in Economic Censuses
Food manufacturing
Textile mill products
Apparel
Lumber and wood
Furniture and fixtures
Paper and allied products
Printing and publishing
Chemicals and allied products
Petroleum and coal products
Rubber and plastics
Leather
Stone, clay and glass
Primary metals
Fabricated metals
Machinery, except electrical
Electric and electronic equipment
Transportation equipment
Instrument and related products
Miscellaneous manufacturing
Distribution of Human Capital (s) for Manufacturing 1992, Continuers

Percentage of Employment

Decile of the Skill Distribution

All Sectors in Economic Censuses
Food manufacturing
Textile mill products
Apparel
Lumber and wood
Furniture and fixtures
Paper and allied products
Printing and publishing
Chemicals and allied products
Petroleum and coal products
Rubber and plastics
Leather
Stone, clay and glass
Primary metals
Fabricated metals
Machinery, except electrical
Electric and electronic equipment
Transportation equipment
Instrument and related products
Miscellaneous manufacturing
Distribution of Human Capital (s) for Retail Trade 1992

Decile of the Skill Distribution

Percentage of Employment

All Sectors in Economic Censuses
Building materials and garden supplies
General merchandise stores
Building materials and garden supplies
Automobile dealers and service stations
Apparel and accessory stores
Furniture and home furnishing stores
Eating and drinking places
Miscellaneous retail

Decile of the Skill Distribution
Distribution of Change in Human Capital (s) for Finance, Insurance, and Real Estate 1992-1997, Continuers

Decile of the Skill Distribution

Change in Percentage of Employment

-10.0% -5.0% 0.0% 5.0% 10.0% 15.0% 20.0% 25.0% 30.0%

1 2 3 4 5 6 7 8 9 10

-10.0% -5.0% 0.0% 5.0% 10.0%

All Sectors in Economic Censuses
Banking
Credit agencies other than banks
Security, commodity, brokers and services
Insurance carriers
Insurance agents and brokers
Real estate
Holding and other investments
Distribution of Human Capital (Theta) for Manufacturing 1997

[Graph showing the distribution of human capital across different sectors of manufacturing, with axes labeled as Decile of the Skill Distribution on the x-axis and Percentage of Employment on the y-axis.]
Distribution of Human Capital (Theta) for Manufacturing 1992, Continuers

Decile of the Skill Distribution

Percentage of Employment

0.0% 5.0% 10.0% 15.0% 20.0% 25.0% 30.0%

All Sectors in Economic Censuses
Food manufacturing
Textile mill products
Apparel
Lumber and wood
Furniture and fixtures
Paper and allied products
Printing and publishing
Chemicals and allied products
Petroleum and coal products
Rubber and plastics
Leather
Stone, clay and glass
Primary metals
Fabricated metals
Machinery, except electrical
Electric and electronic equipment
Transportation equipment
Instrument and related products
Miscellaneous manufacturing
Distribution of Human Capital (Theta) for Manufacturing 1997, Entrants

Decile of the Skill Distribution
Percentage of Employment

All Sectors in Economic Censuses
Food manufacturing
Textile mill products
Apparel
Lumber and wood
Furniture and fixtures
Paper and allied products
Printing and publishing
Chemicals and allied products
Petroleum and coal products
Rubber and plastics
Leather
Stone, clay and glass
Primary metals
Fabricated metals
Machinery, except electrical
Electric and electronic equipment
Transportation equipment
Instruments and related products
Miscellaneous manufacturing
Distribution of Change in Human Capital (Theta) for Manufacturing 1992-1997, Contintuers

Decile of the Skill Distribution

Change in Percentage of Employment

-10.0%
-5.0%
0.0%
5.0%
10.0%
15.0%
20.0%
25.0%
30.0%

All Sectors in Economic Censuses
Food manufacturing
Textile mill products
Apparel
Lumber and wood
Furniture and fixtures
Paper and allied products
Printing and publishing
Chemicals and allied products
Petroleum and coal products
Rubber and plastics
Leather
Stone, clay and glass
Primary metals
Fabricated metals
Machinery, except electrical
Electric and electronic equipment
Transportation equipment
Instrument and related products
Miscellaneous manufacturing
Distribution of Human Capital for Retail Trade 1992, Continuers

Decile of the Skill Distribution

Percentage of Employment

All Sectors in Economic Censuses
Building materials and garden supplies
General merchandise stores
Building materials and garden supplies
Automobile dealers and service stations
Apparel and accessory stores
Furniture and home furnishing stores
Eating and drinking places
Miscellaneous retail

Decile of the Skill Distribution
Distribution of Human Capital (Theta) for Finance, Insurance, and Real Estate 1992

Decile of the Skill Distribution

Percentage of Employment

- All Sectors in Economic Censuses
- Banking
- Credit agencies other than banks
- Security, commodity, brokers and services
- Insurance carriers
- Insurance agents and brokers
- Real estate
- Holding and other investments
Distribution of Human Capital (Theta) for Finance, Insurance, and Real Estate 1992, Continuers

All Sectors in Economic Censuses
Banking
Credit agencies other than banks
Security, commodity, brokers and services
Insurance carriers
Insurance agents and brokers
Real estate
Holding and other investments

Decile of the Skill Distribution
Percentage of Employment

0.0% 5.0% 10.0% 15.0% 20.0% 25.0% 30.0%
Distribution of Human Capital (Theta) for Finance, Insurance, and Real Estate 1997, Entrants

- Distribution of Human Capital (Theta) for Finance, Insurance, and Real Estate 1997, Entrants

- Percentage of Employment

- Decile of the Skill Distribution

- All Sectors in Economic Censuses
- Banking
- Credit agencies other than banks
- Security, commodity, brokers and services
- Insurance carriers
- Insurance agents and brokers
- Real estate
- Holding and other investments

- X-axis: Decile of the Skill Distribution
- Y-axis: Percentage of Employment

- The graph shows the distribution of human capital across different sectors, with a focus on entrants in 1997.
Distribution of Change in Human Capital (Theta) for Finance, Insurance, and Real Estate
1992-1997, Continers

-5.0%
0.0%
5.0%
10.0%
15.0%
20.0%
25.0%
30.0%

Decile of the Skill Distribution

All Sectors in Economic Censuses
Banking
Credit agencies other than banks
Security, commodity, brokers and services
Insurance carriers
Insurance agents and brokers
Real estate
Holding and other investments

Change in Percentage of Employment

Decile of the Skill Distribution