Title: Productivity, Job Creation and Entrepreneurship

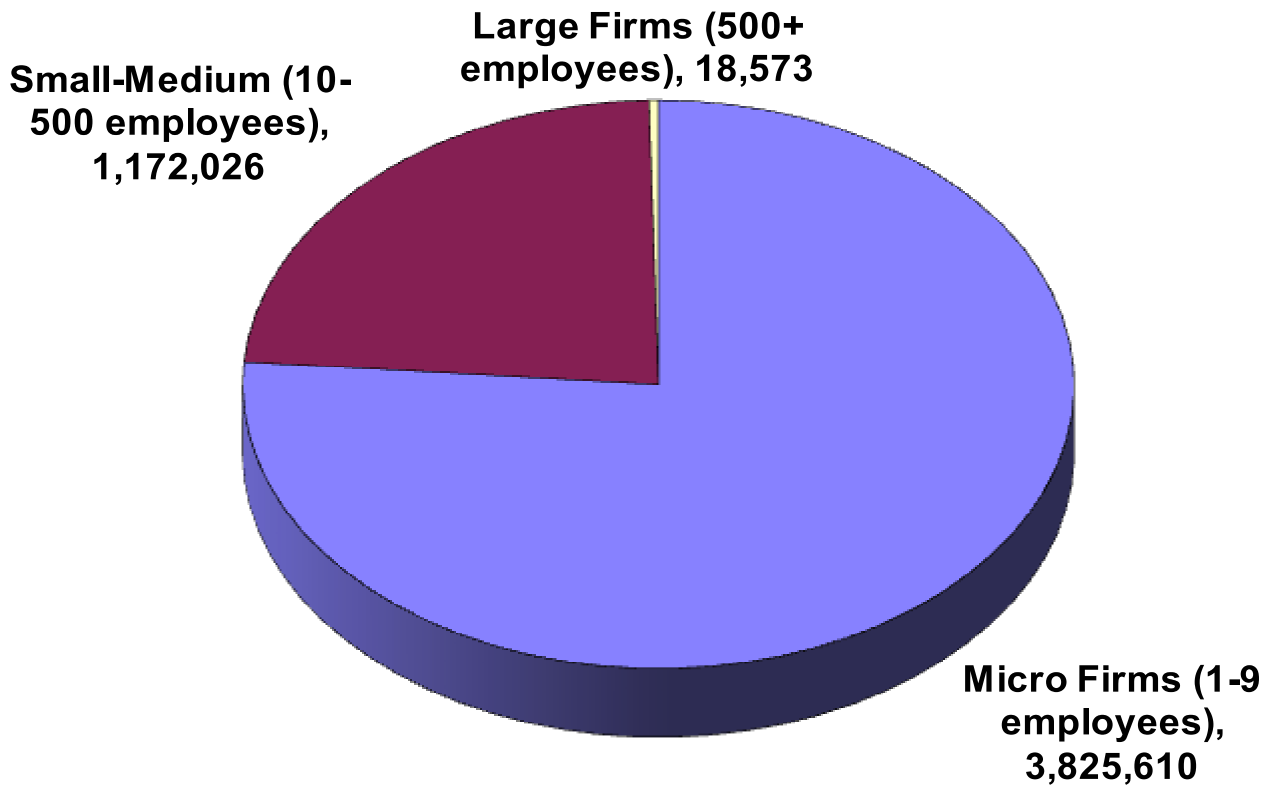
Lecture Notes for NBER Entrepreneurship Bootcamp

July 2013

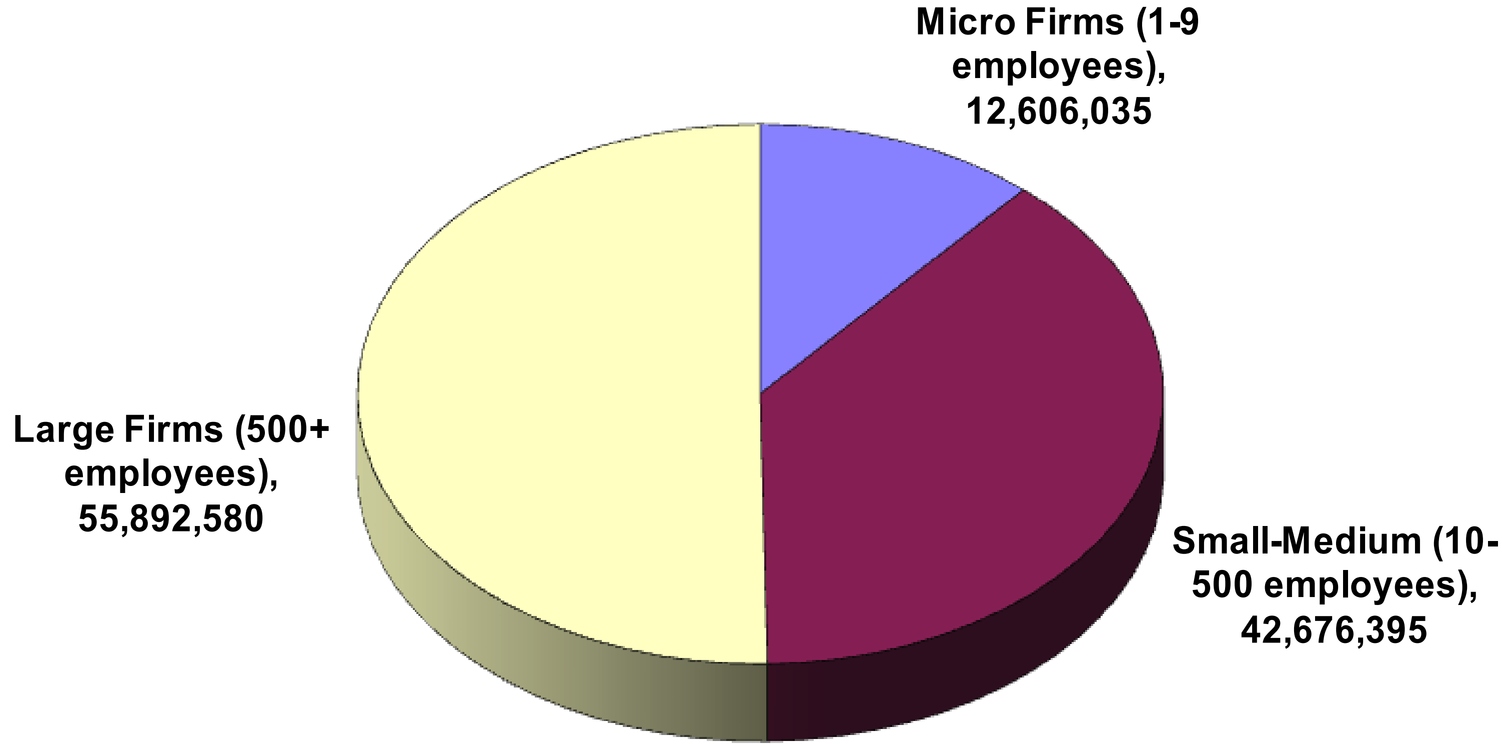
By John Haltiwanger

University of Maryland and NBER

Share of Firms by Firm Size, 2010



Share of Employment by Firm Size, 2010



CHRYSLER

Ford

GM

kmart

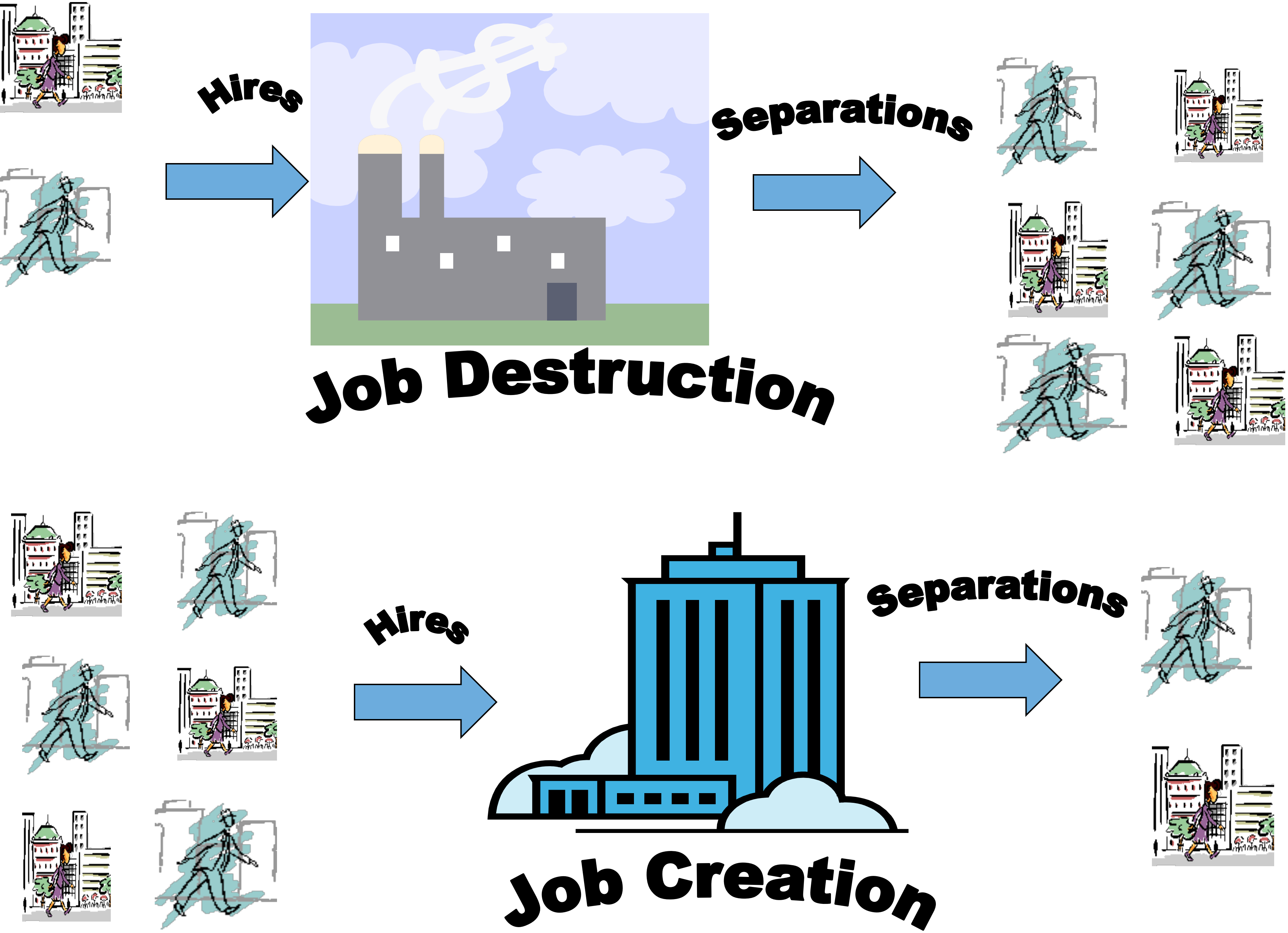
USS

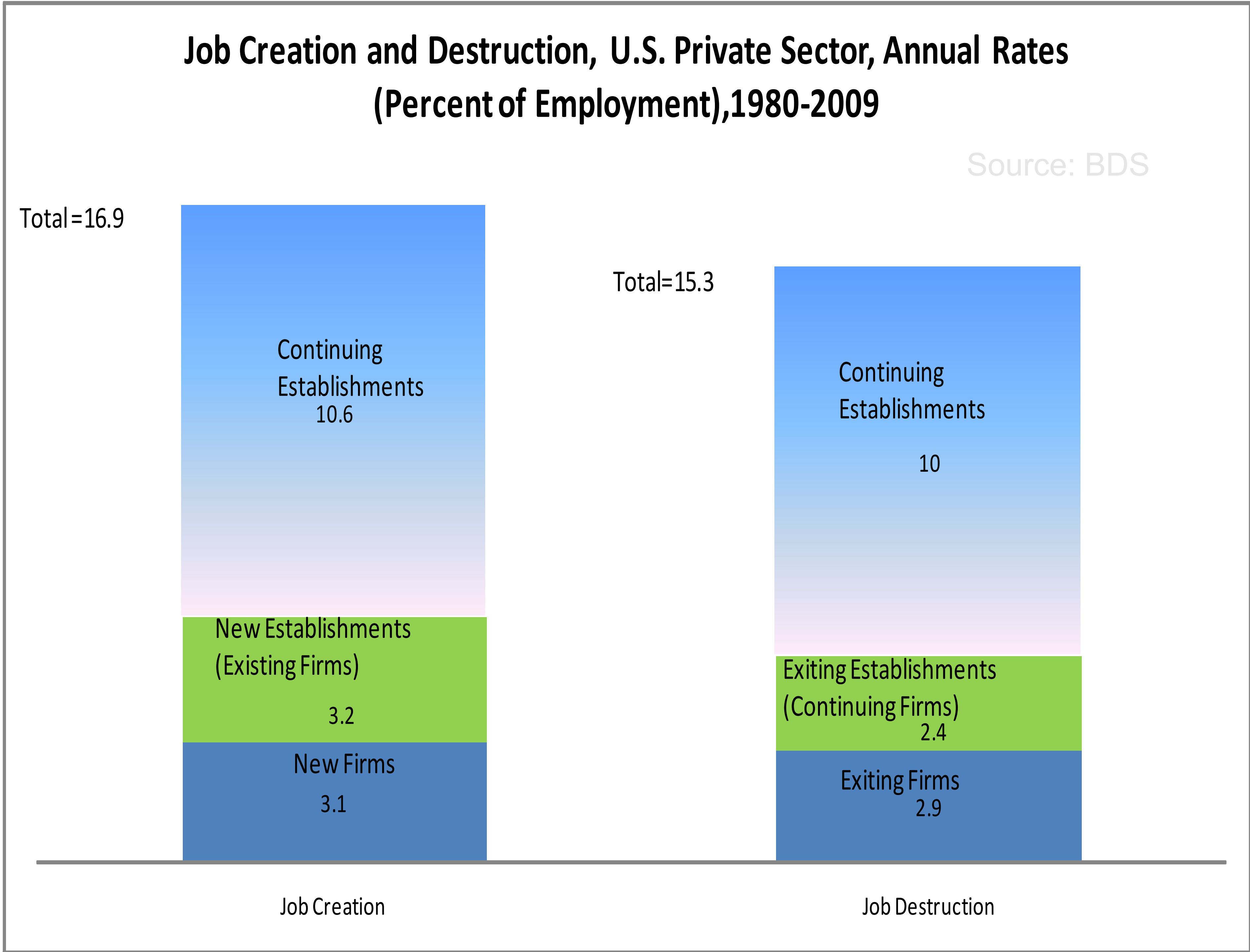
TOYOTA

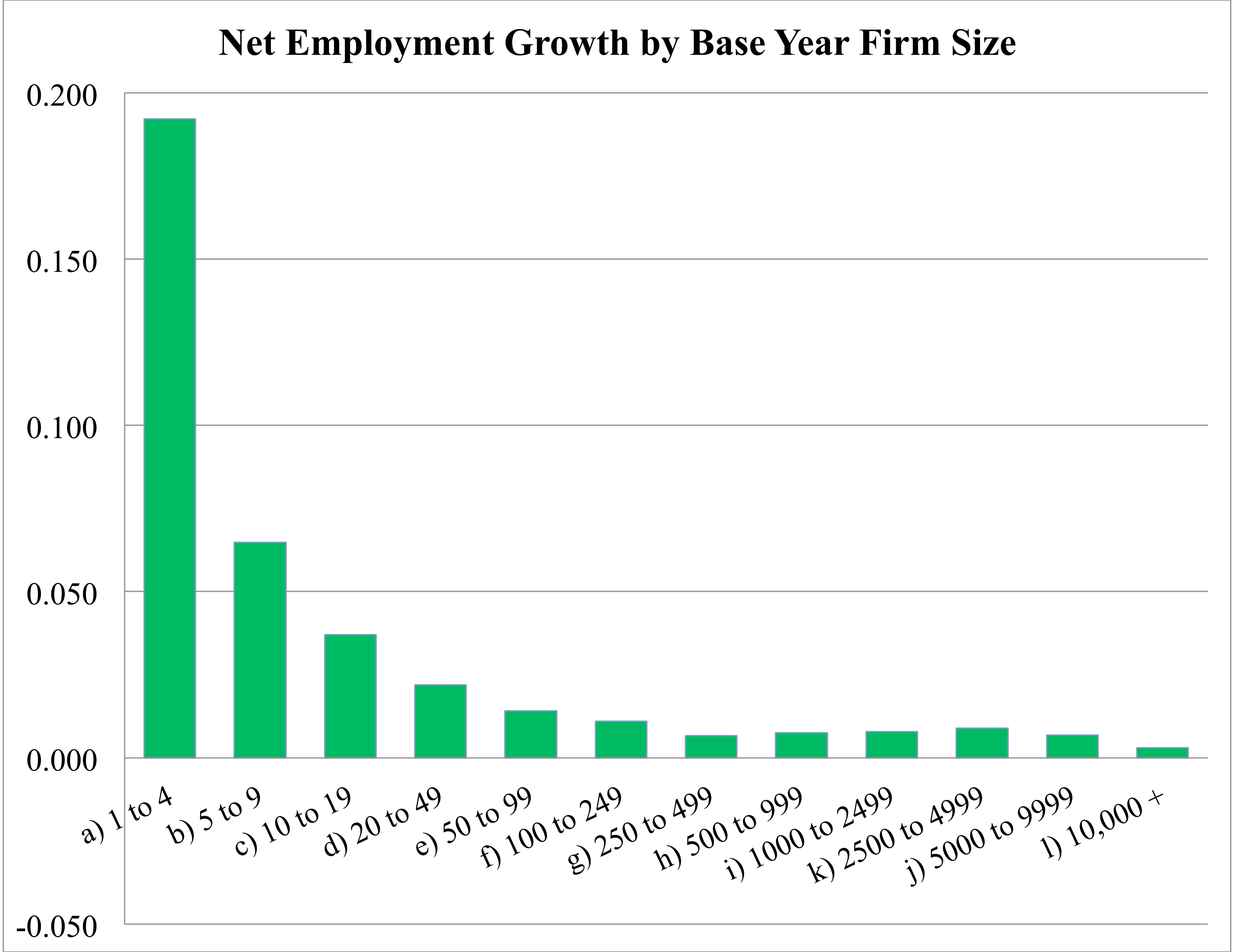
Google

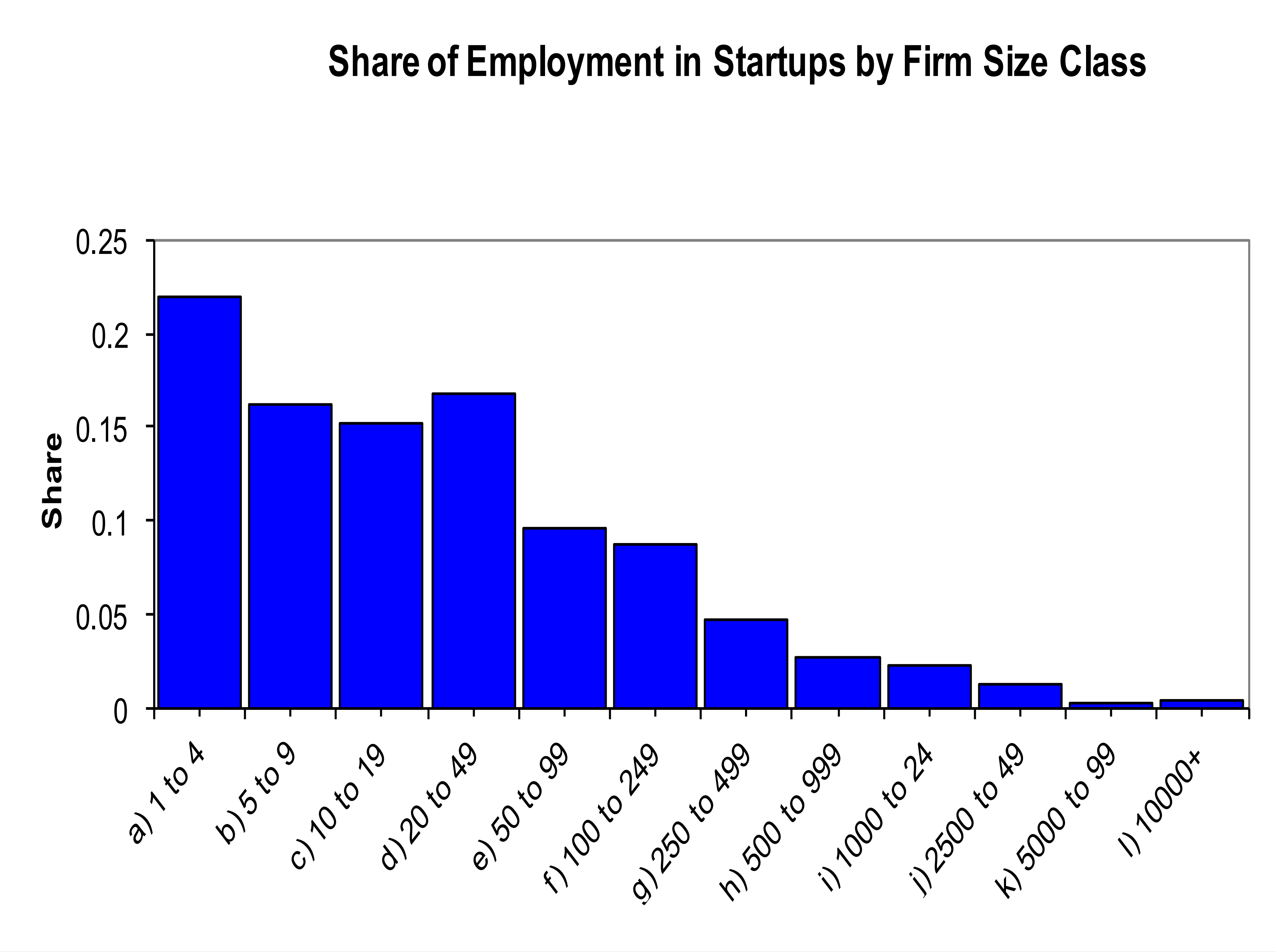
HONDA

STARBUCKS COFFEE

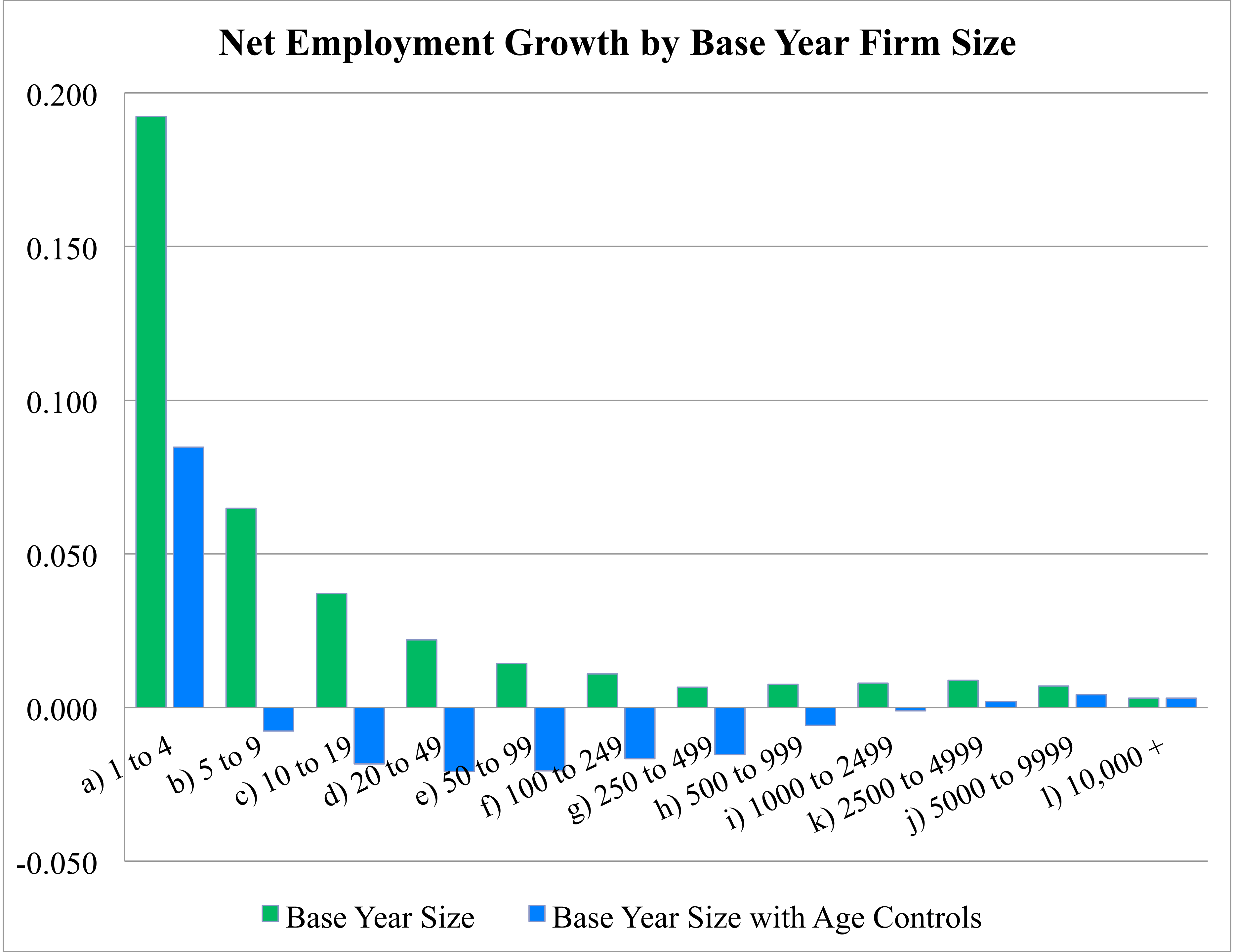

Hires
Separations
Job Destruction
Hires
Separations
Job Creation

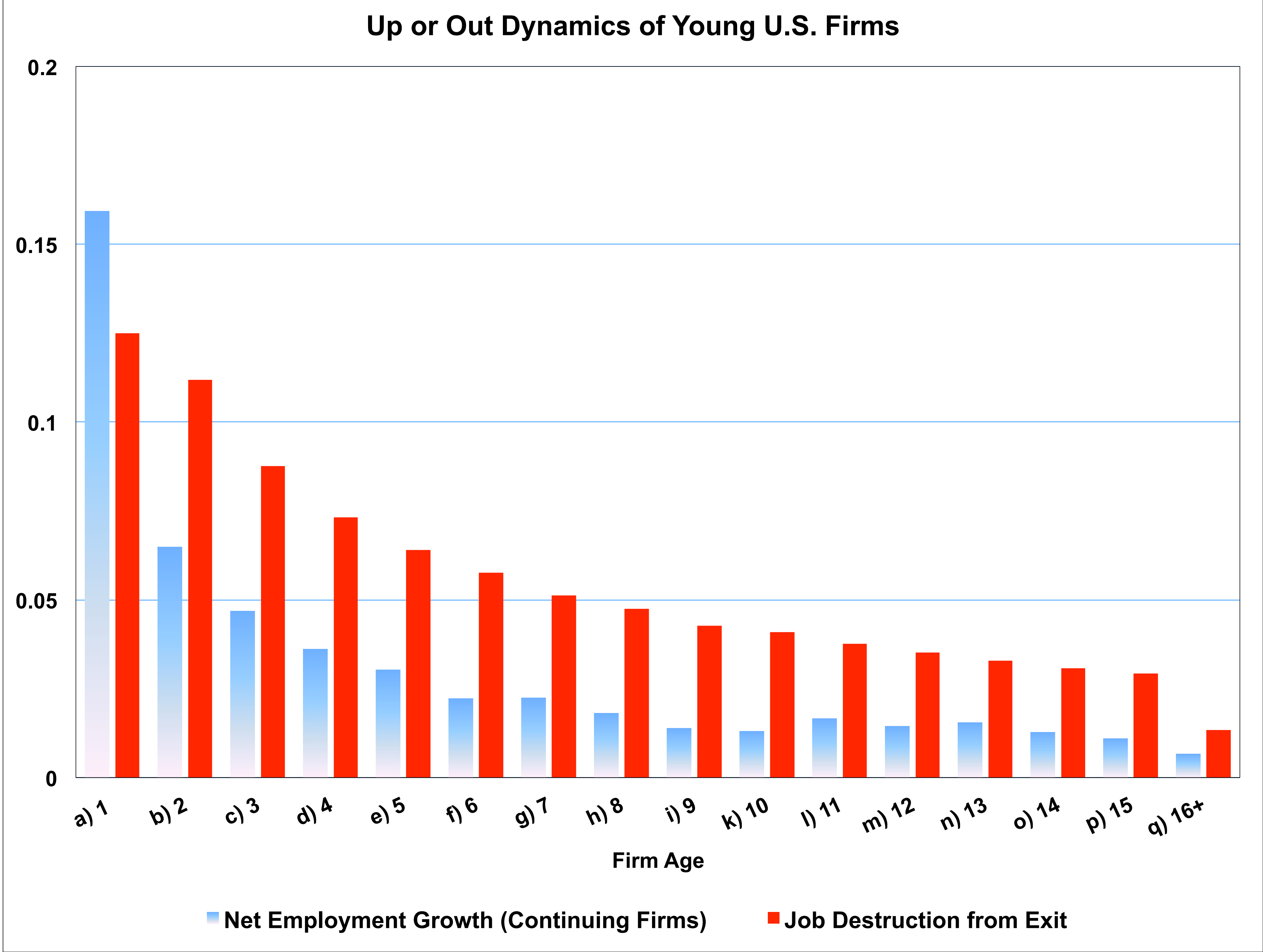

Job Creation and Destruction, U.S. Private Sector, Annual Rates
(Percent of Employment),1980-2009
Source: BDS
Total=16.9
Continuing Establishments
10.6
New Establishments (Existing Firms)
3.2
New Firms
3.1
Total=15.3
Continuing Establishments
10
Exiting Establishments (Continuing Firms)
2.4
Exiting Firms
2.9
Job Creation
Job Destruction


Net Employment Growth by Base Year Firm Size
0.200
0.150
0.100
0.050
0.000
-0.050
a) 1 to 4
b) 5 to 9
c) 10 to 19
d) 20 to 49
e) 50 to 99
f) 100 to 249
g) 250 to 499
h) 500 to 999
i) 1000 to 2499
k) 2500 to 4999
j) 5000 to 9999
l) 10,000 +

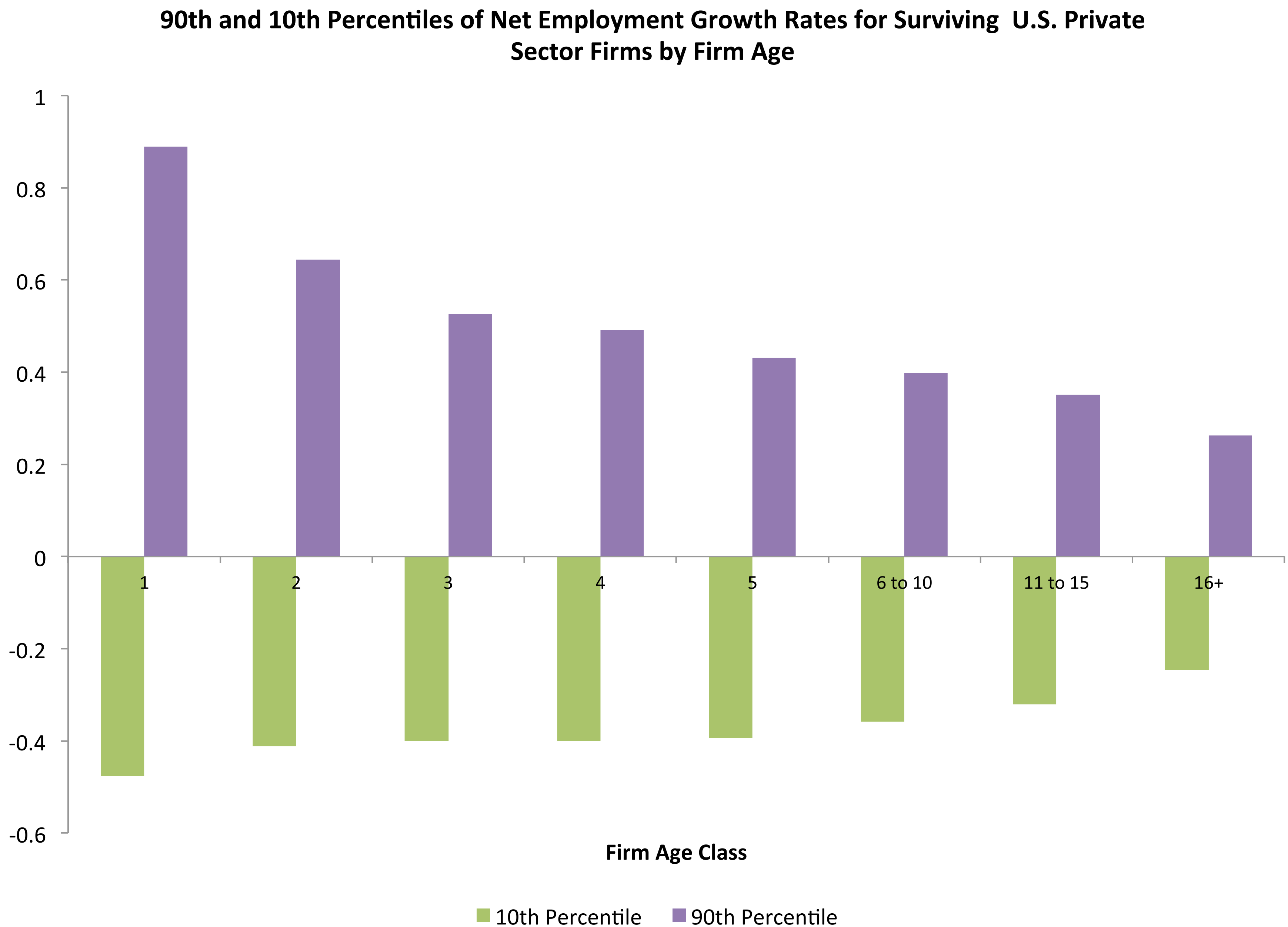


Share of Employment in Startups by Firm Size Class
Share
0.25
0.2
0.15
0.1
0.05
0
a) 1 to 4
b) 5 to 9
c) 10 to 19
d) 20 to 49
e) 50 to 99
f) 100 to 249
g) 250 to 499
h) 500 to 999
i) 1000 to 24
j) 2500 to 49
k) 5000 to 99
l) 10000+

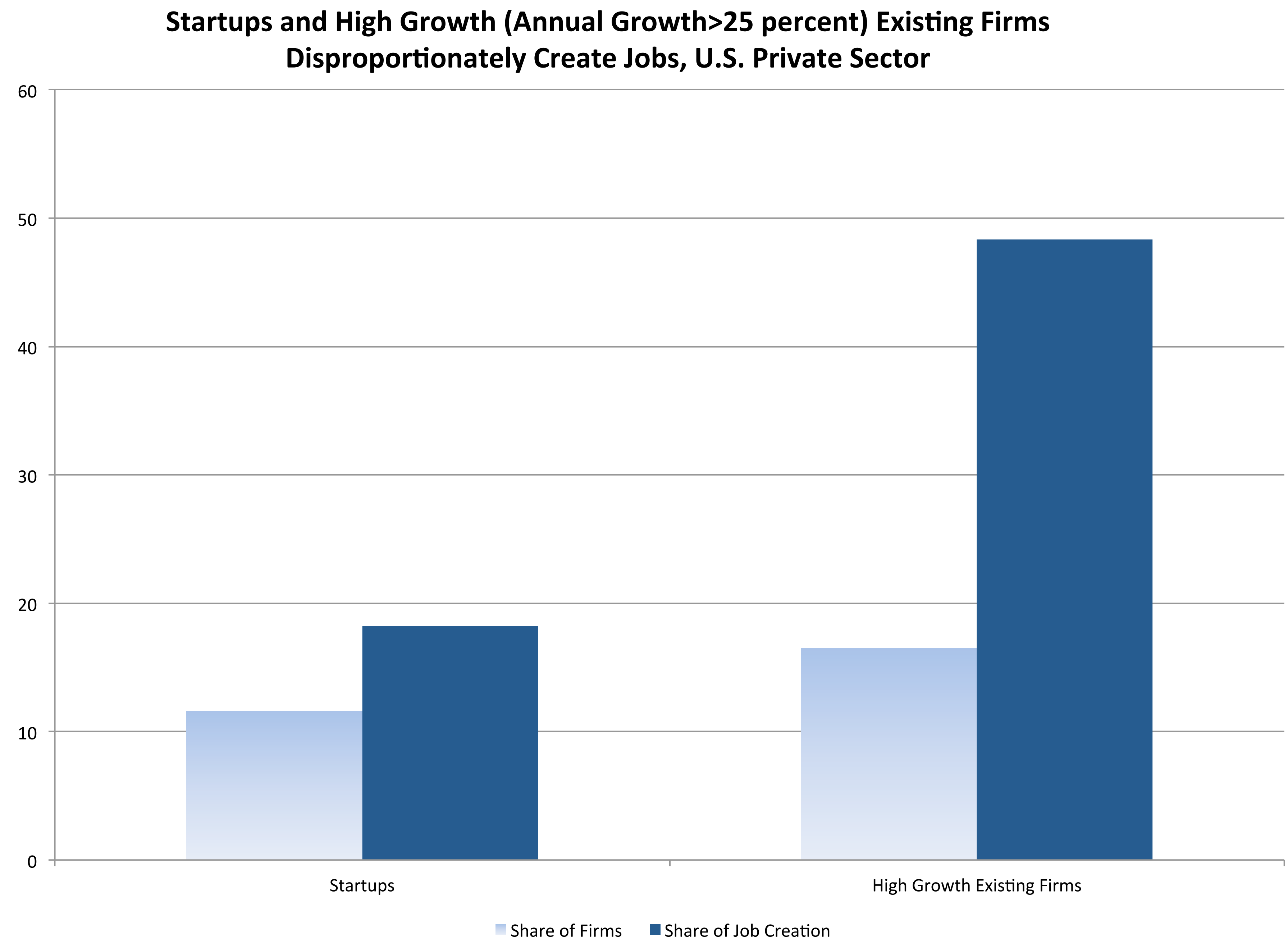

Net Employment Growth by Base Year Firm Size
0.200
0.150
0.100
0.050
0.000
-0.050
a) 1 to 4
b) 5 to 9
c) 10 to 19
d) 20 to 49
e) 50 to 99
f) 100 to 249
g) 250 to 499
h) 500 to 999
i) 1000 to 2499
k) 2500 to 4999
j) 5000 to 9999
l) 10,000 +
Base Year Size
Base Year Size with Age Controls



Up or Out Dynamics of Young U.S. Firms
0.2
0.15
0.1
0.05
0
a) 1
b) 2
c) 3
d) 4
e) 5
f) 6
g) 7
h) 8
i) 9
k) 10
l) 11
m) 12
n) 13
o) 14
p) 15
q) 16+
Firm Age
Net Employment Growth (Continuing Firms)
Job Destruction from Exit



Source: Firm-level data used by Haltiwanger, Jarmin and Miranda (2011)

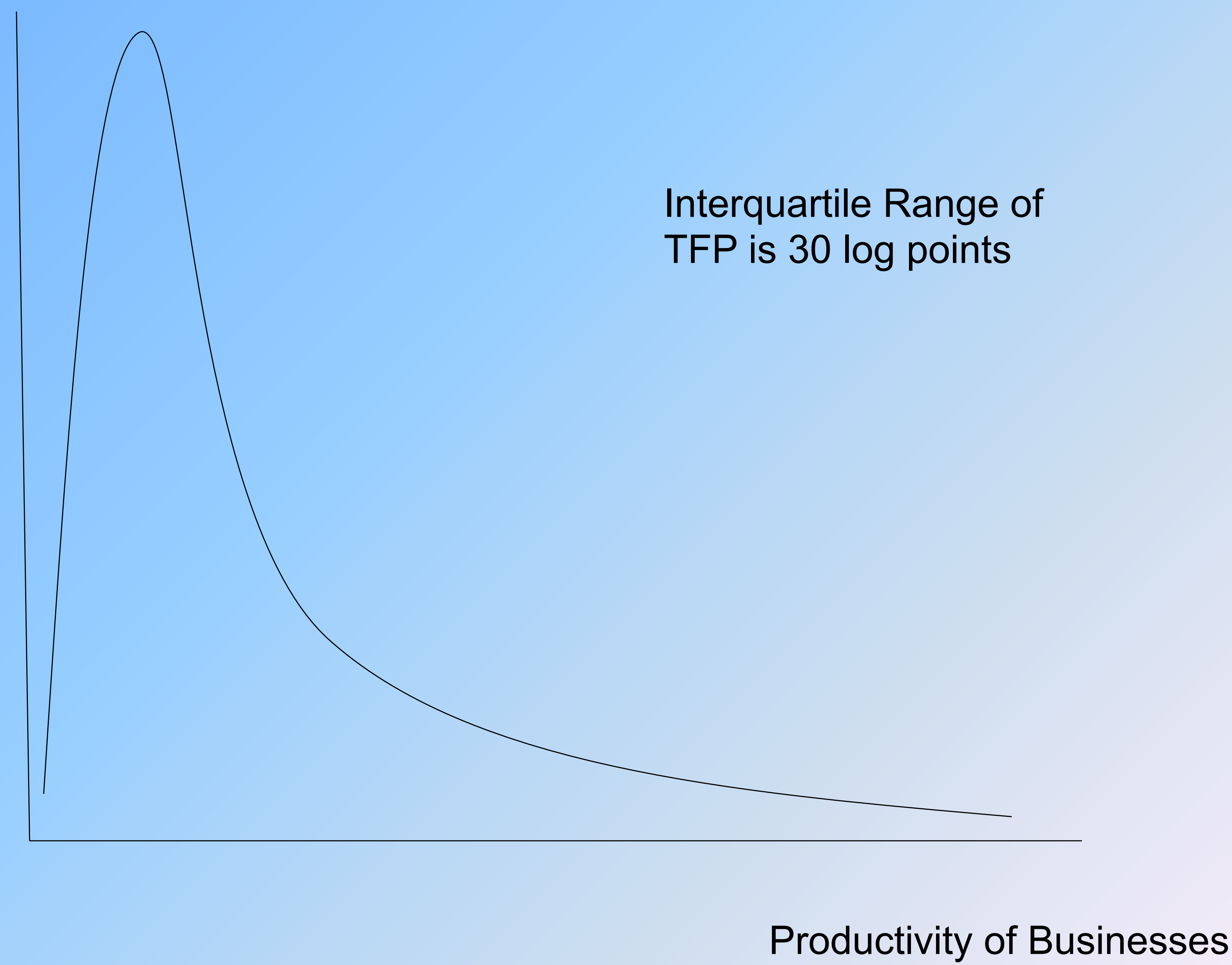


Source: Tabulations from Firm-Level Data Used in Haltiwanger, Jarmin and Miranda (

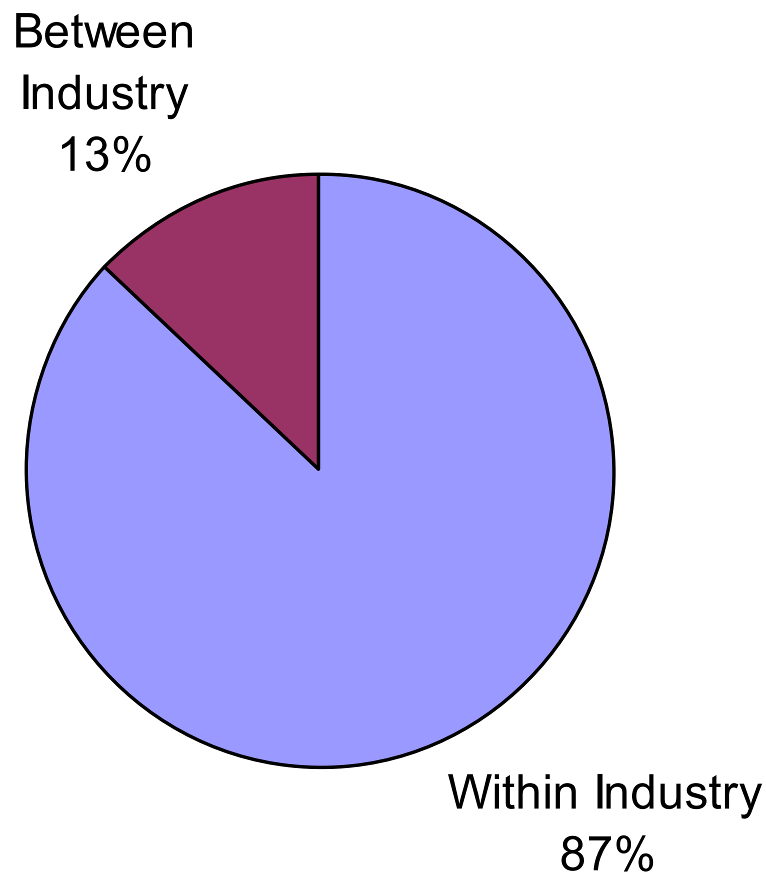
What accounts for cross sectional and dynamic patterns?

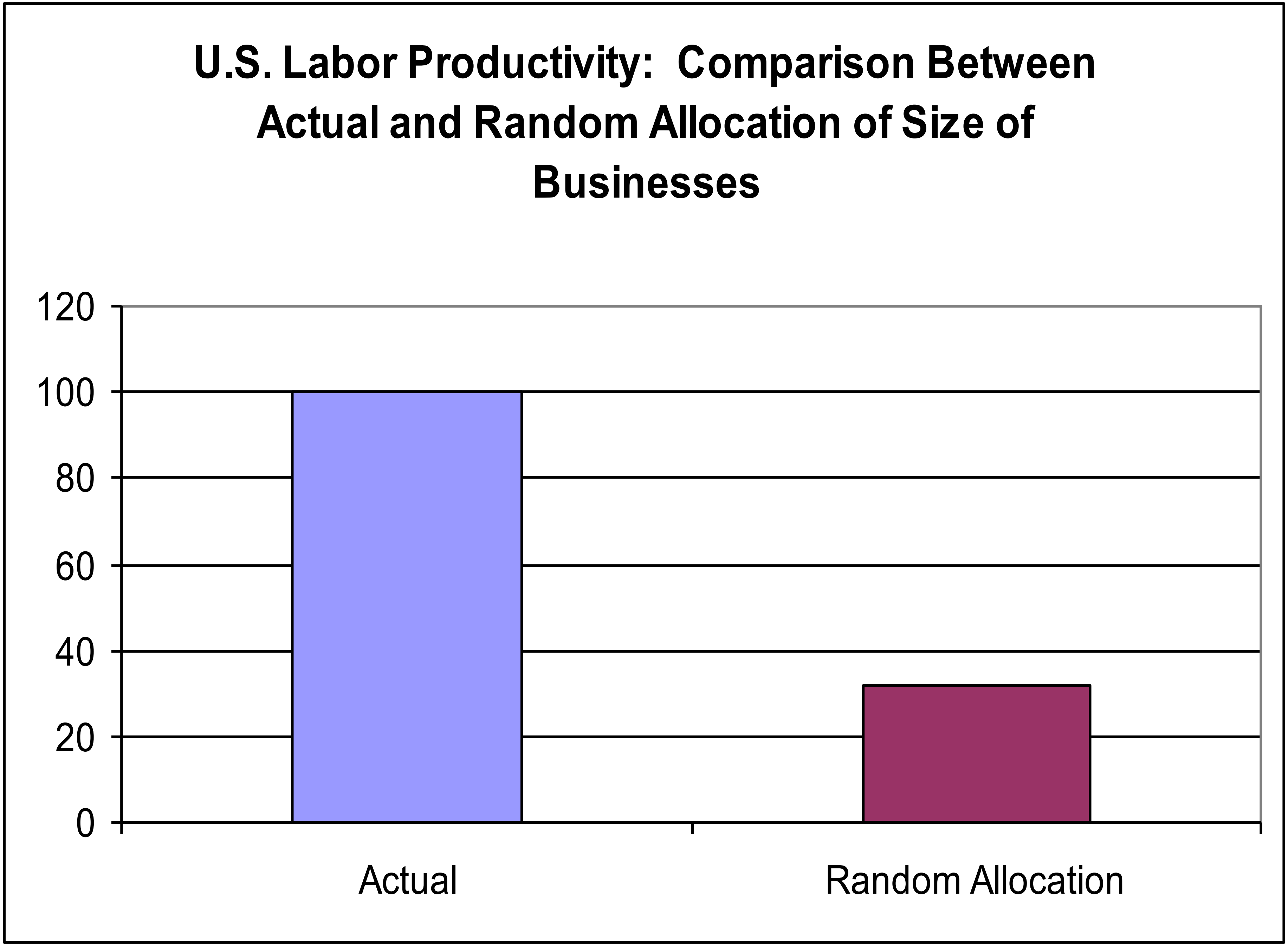
- Very skewed size distribution
- Constant state of churning
  - Wave of entering firms contributes substantially to job creation each year
  - Most exit
  - Conditional on survival, young businesses grow quickly
  - Even amongst large, mature businesses high pace of churning of jobs and businesses

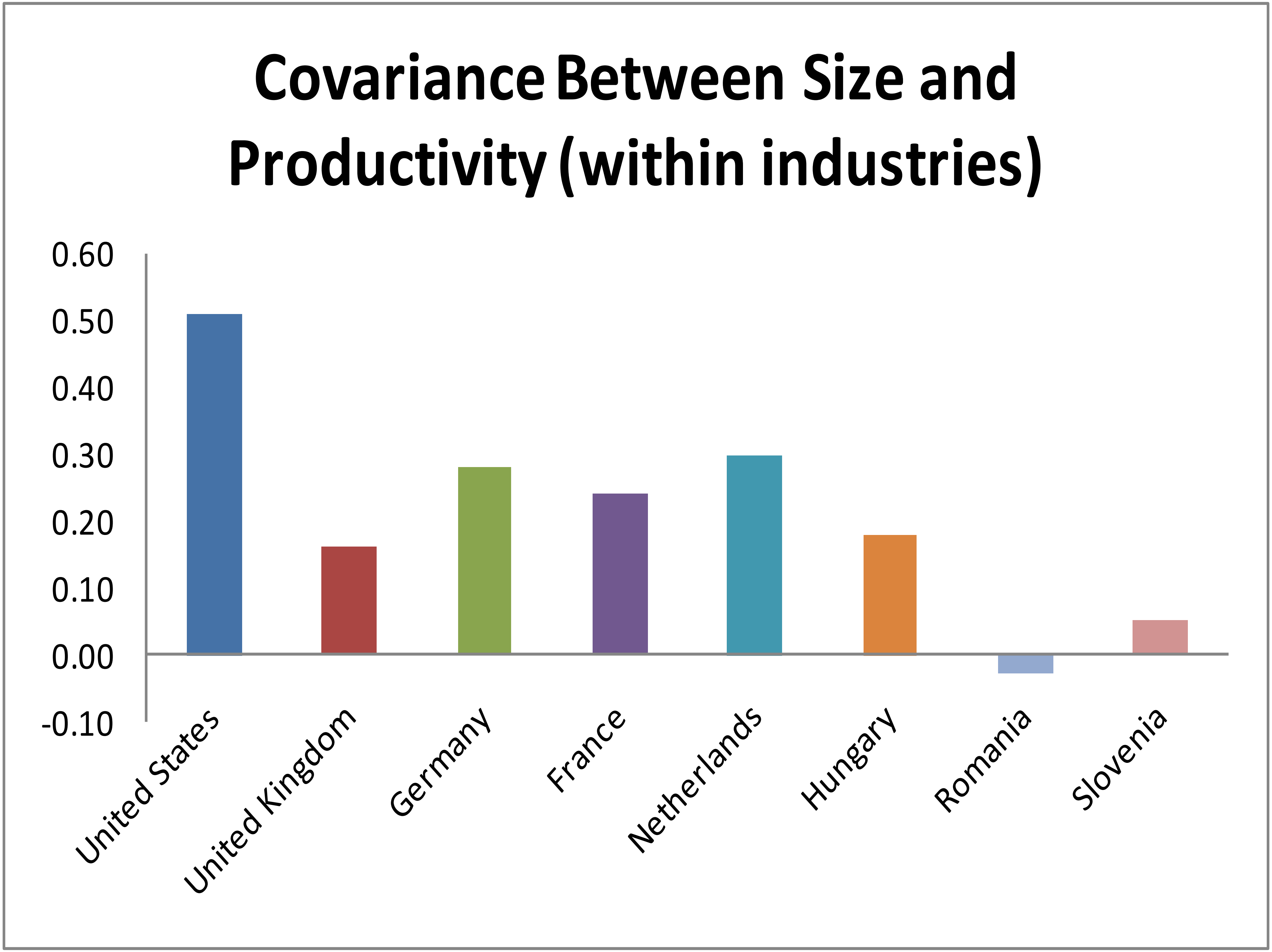
Productivity Distribution Within Narrowly Defined Industries

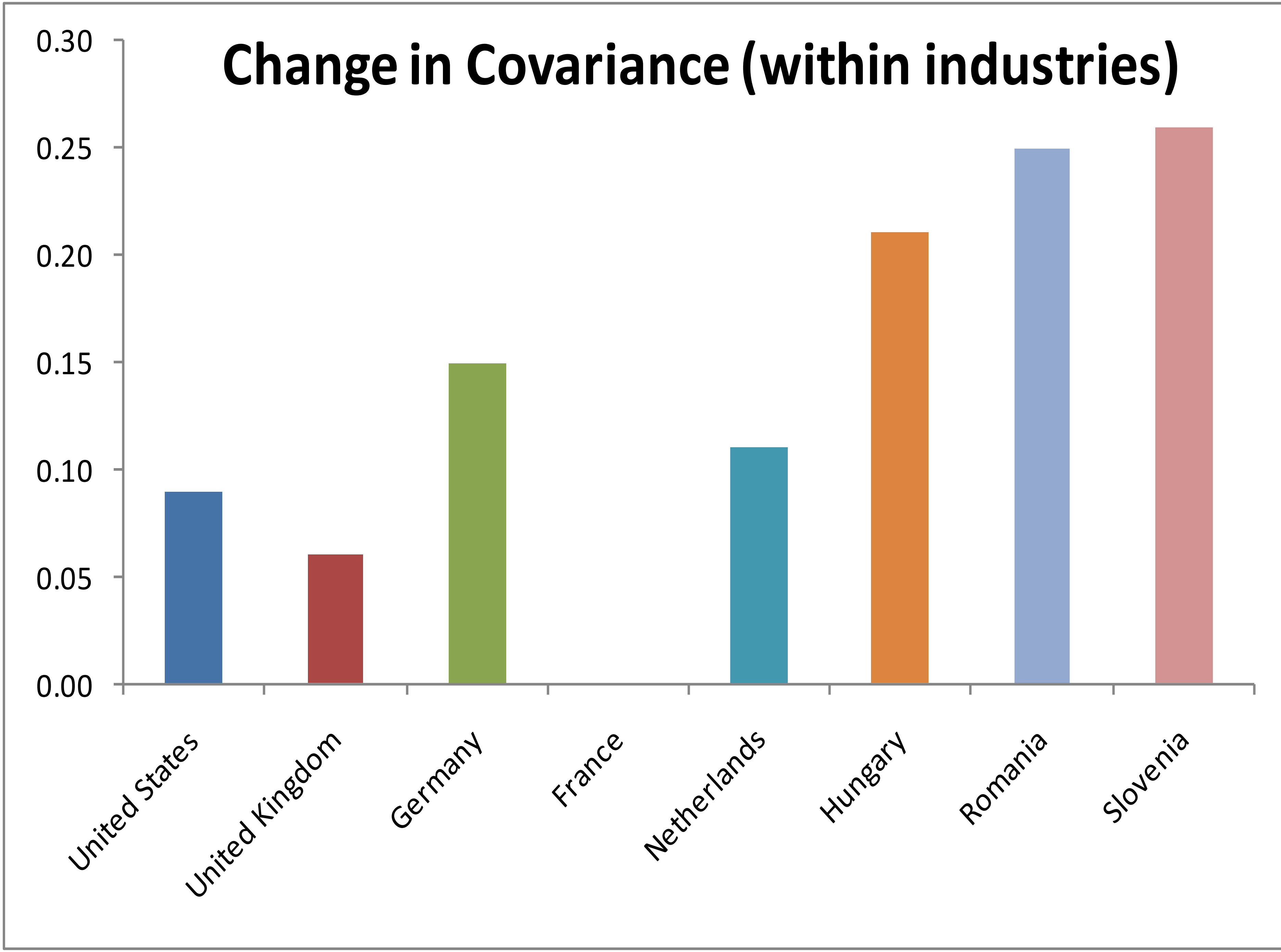


Share of Reallocation Between and Within Detailed Industries

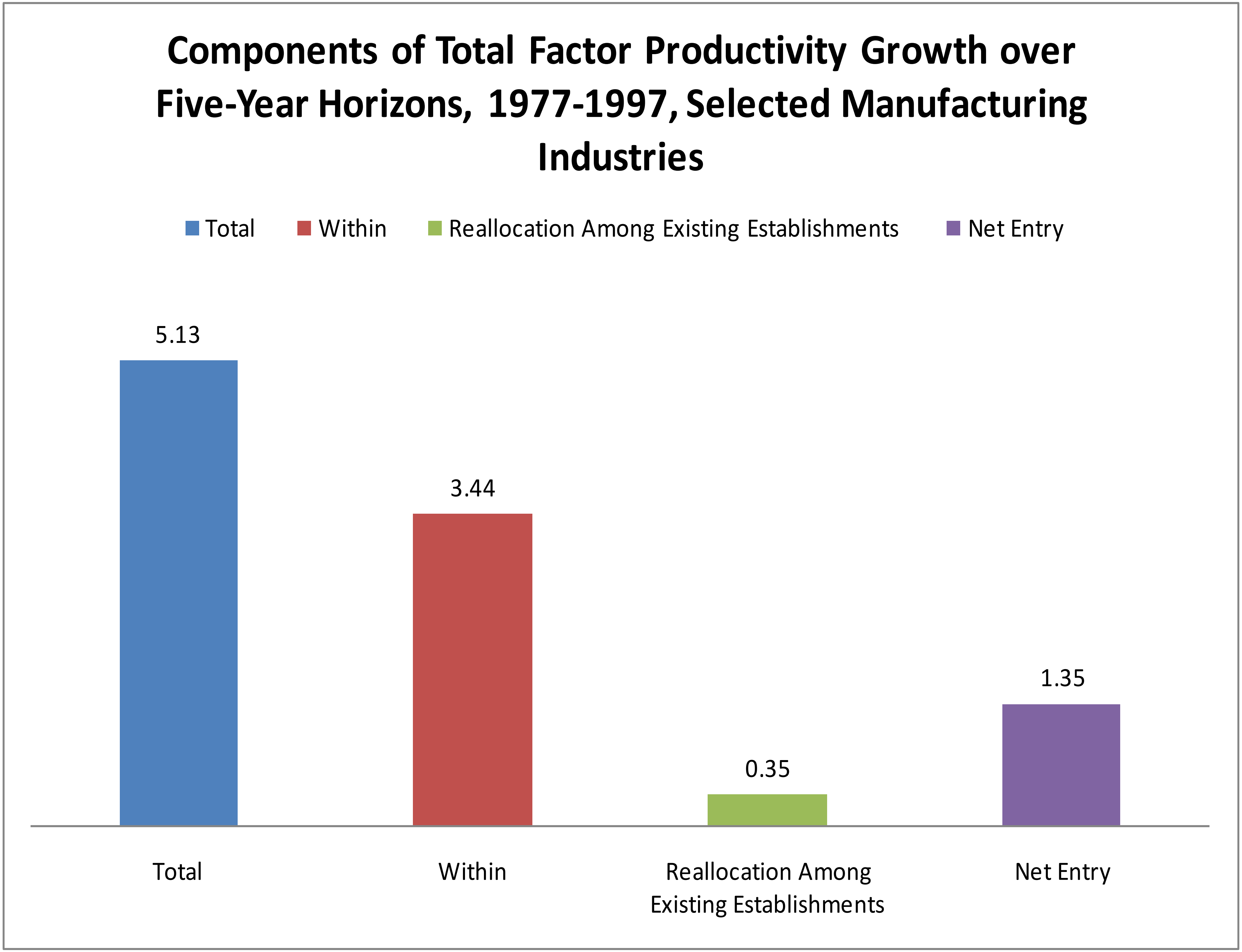


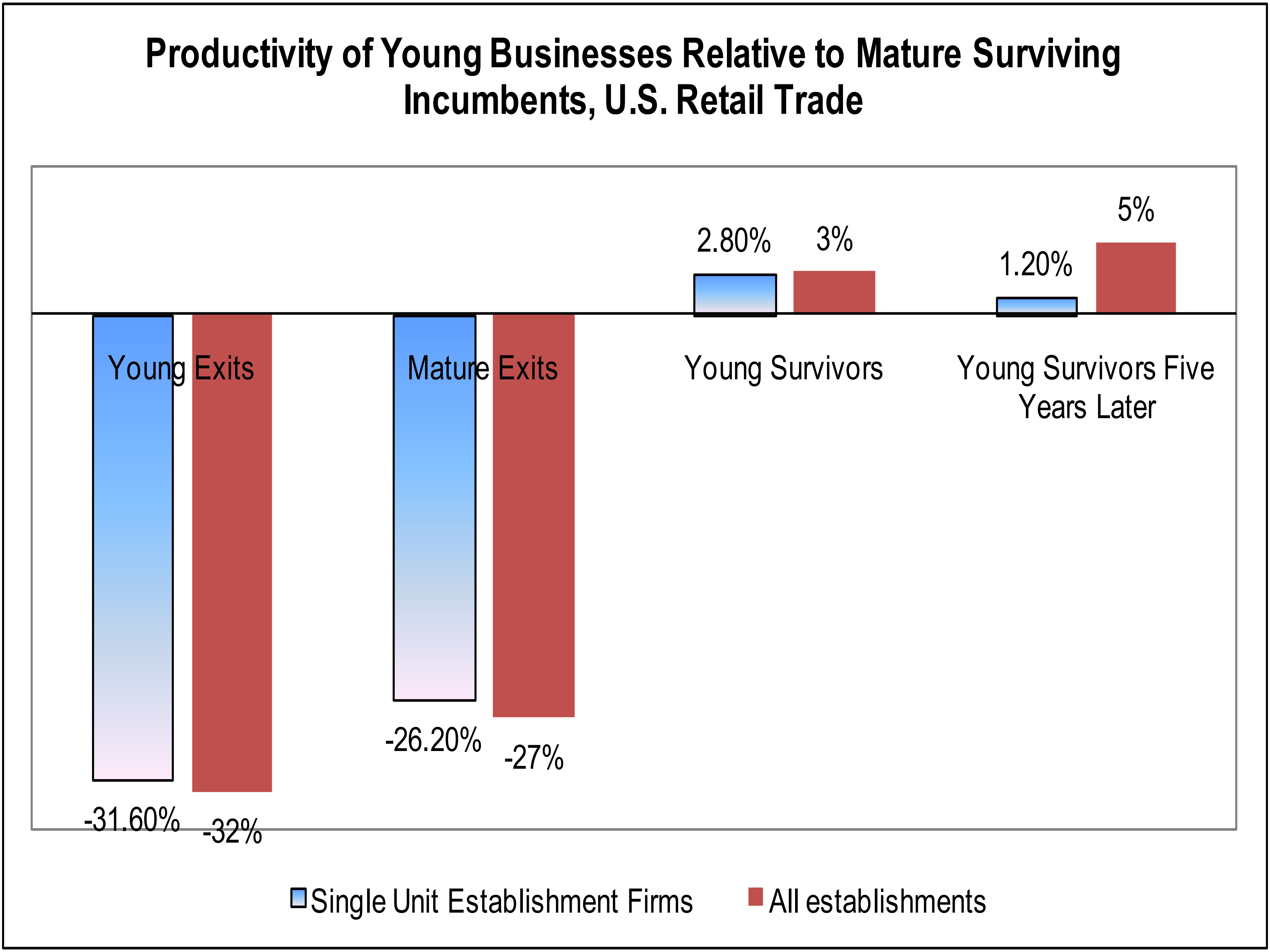

U.S. Labor Productivity: Comparison Between Actual and Random Allocation of Size of Businesses
120
100
80
60
40
20
0
Actual
Random Allocation


Covariance Between Size and Productivity (within industries)
0.60
0.50
0.40
0.30
0.20
0.10
0.00
-0.10
United States
United Kingdom
Germany
France
Netherlands
Hungary
Romania
Slovenia



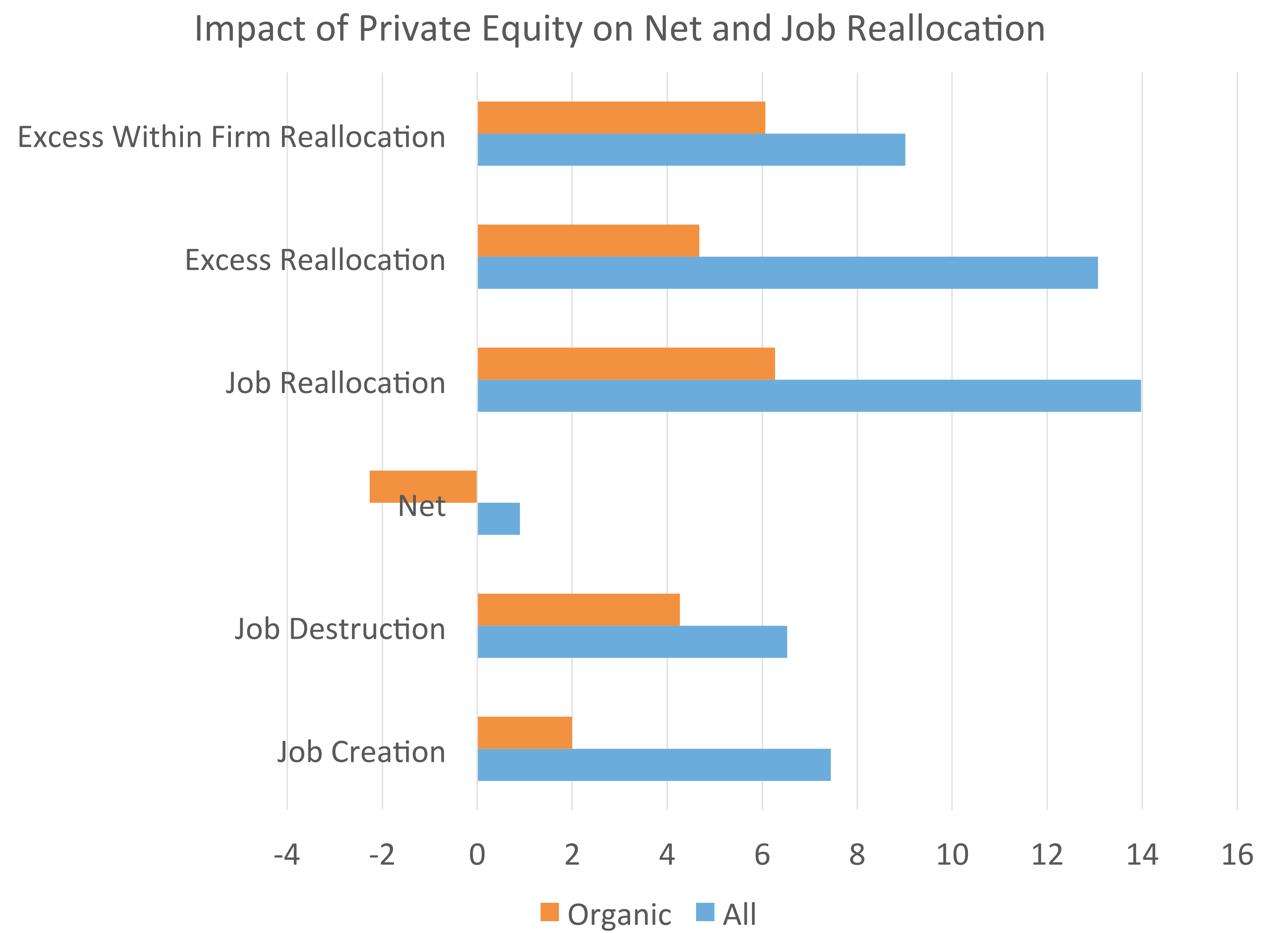
Change in Covariance (within industries)
0.30
0.25
0.20
0.15
0.10
0.05
0.00
United States
United Kingdom
Germany
France
Netherlands
Hungary
Romania
Slovenia

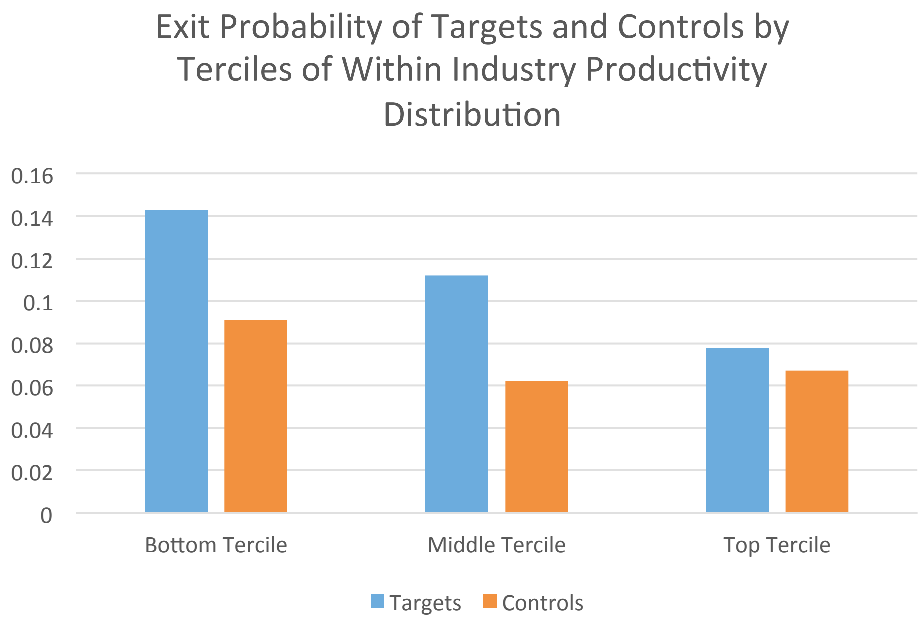

Components of Total Factor Productivity Growth over Five-Year Horizons, 1977-1997, Selected Manufacturing Industries
Total
Within
Reallocation Among Existing Establishments
Net Entry
5.13
3.44
0.35
1.35
Total
Within
Reallocation Among Existing Establishments
Net Entry

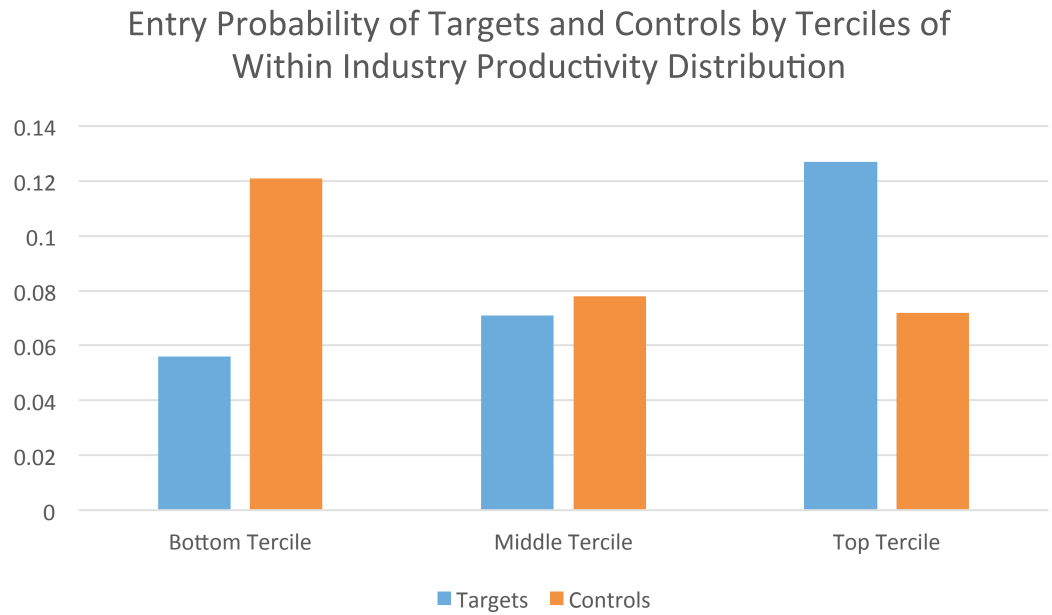

Productivity of Young Businesses Relative to Mature Surviving Incumbents, U.S. Retail Trade
Young Exits
Mature Exits
Young Survivors
Young Survivors Five Years Later
-31.60%
-32%
-26.20%
-27%
2.80%
3%
1.20%
5%
Single Unit Establishment Firms
All establishments

Ownership Change, Management, Financing…

- Many factors underlie the ongoing restructuring and reallocation of businesses
- For allocative efficiency, financial markets need to be facilitating the reallocation of resources to the most productive businesses
- Ownership/management practices and changes are part of these dynamics.
- Example: Private Equity


Impact of Private Equity on Net and Job Reallocation
Excess Within Firm Reallocation
Excess Reallocation
Job Reallocation
Net
Job Destruction
Job Creation
-4
-2
0
2
4
6
8
10
12
14
16
Organic
All


Exit Probability of Targets and Controls by Terciles of Within Industry Productivity Distribution
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
Bottom Tercile
Middle Tercile
Top Tercile
Targets
Controls

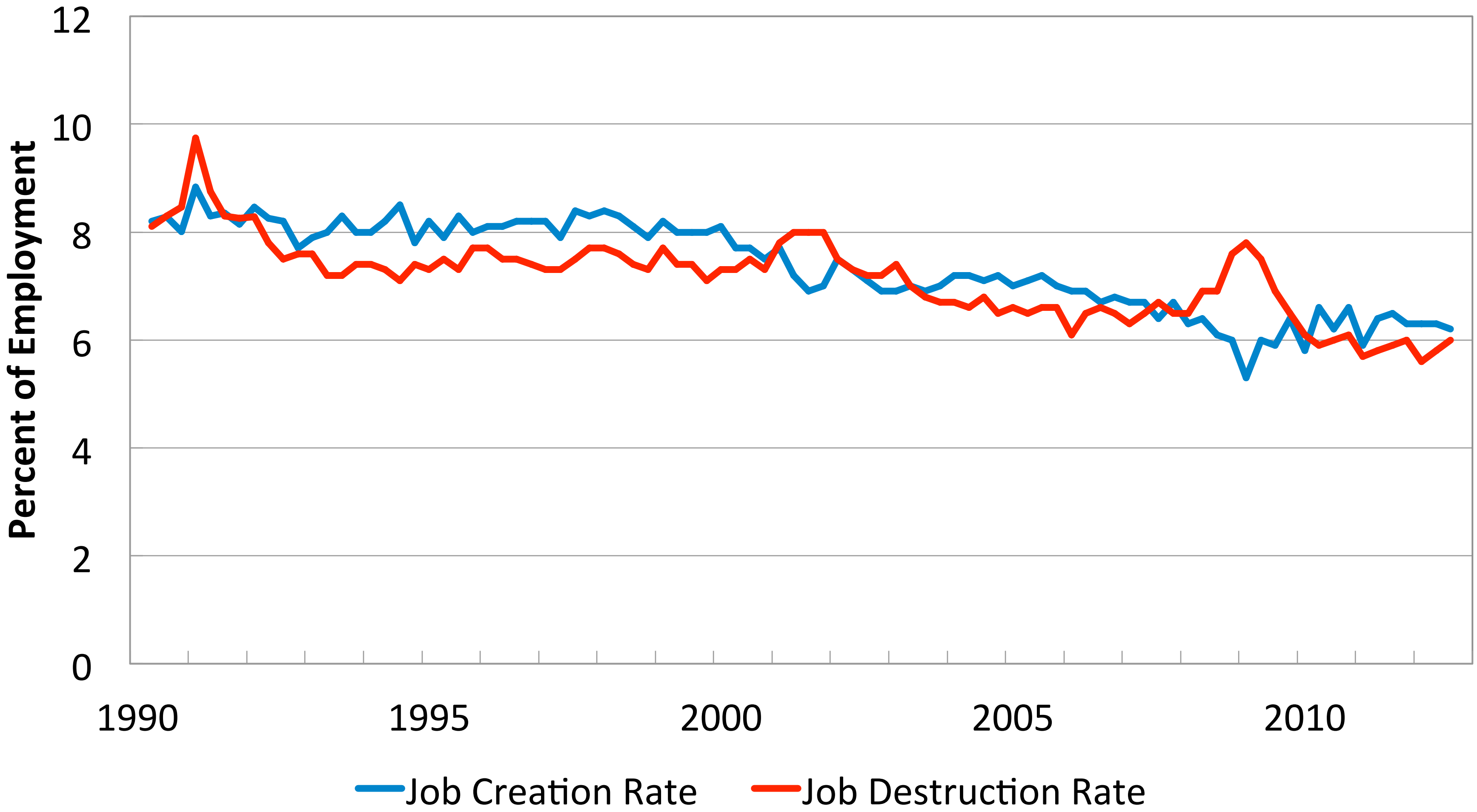

Entry Probability of Targets and Controls by Terciles of Within Industry Productivity Distribution
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
Bottom Tercile
Middle Tercile
Top Tercile
Targets
Controls

Two Year Productivity Growth Impact From Private Equity

Total Productivity Growth Differential	2.09
Excluding Acquisition/Divestiture	1.96
Share of Total from:	
Continuing Establishments	0.20
Net Entry	0.74
Net Acquisition	0.06

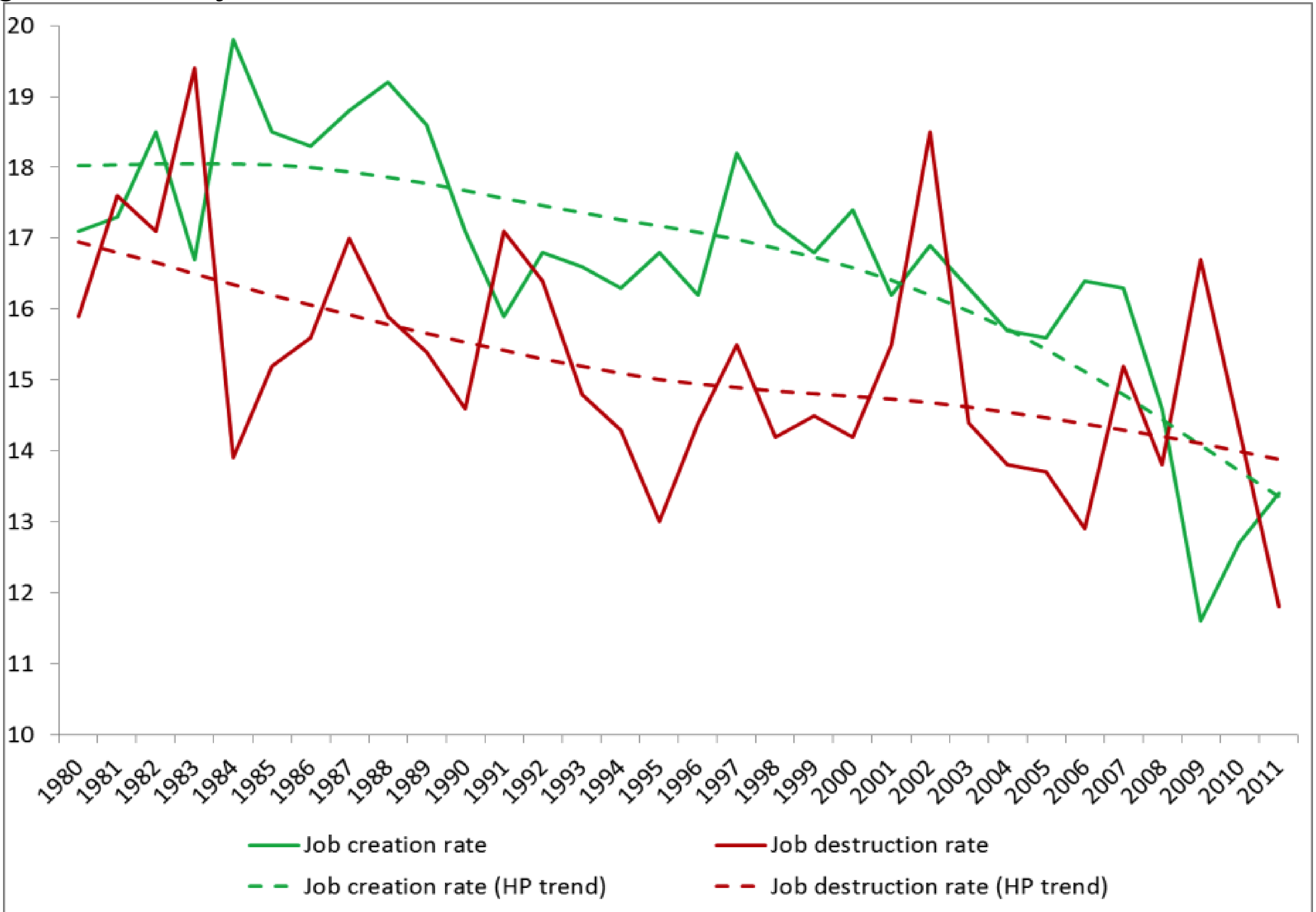
Some Disturbing Trends?

Declining Pace of Creation and Destruction in BED



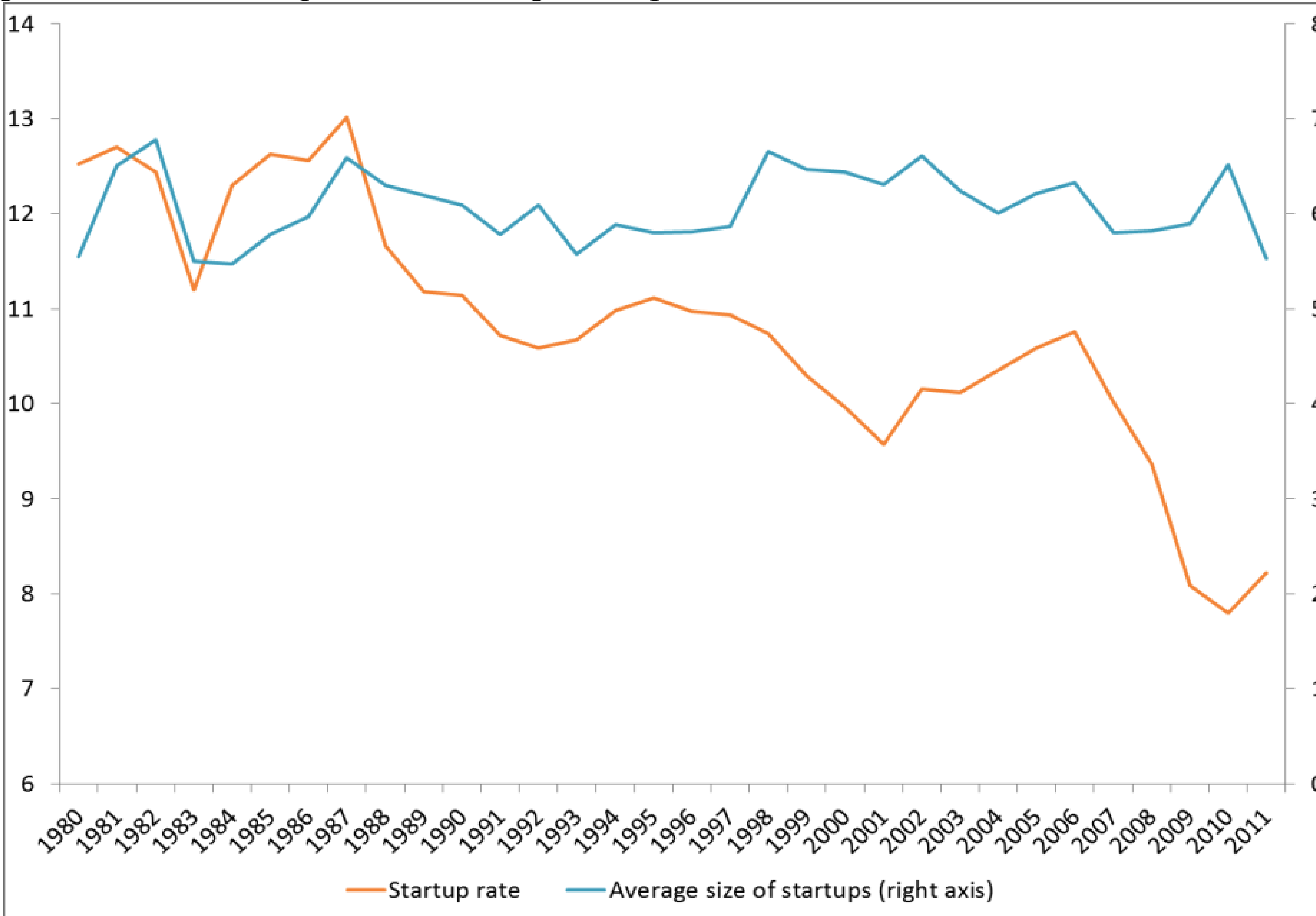
Source: BLS BED DATA

Figure 1: Annual job creation and destruction rates, 1980-2011



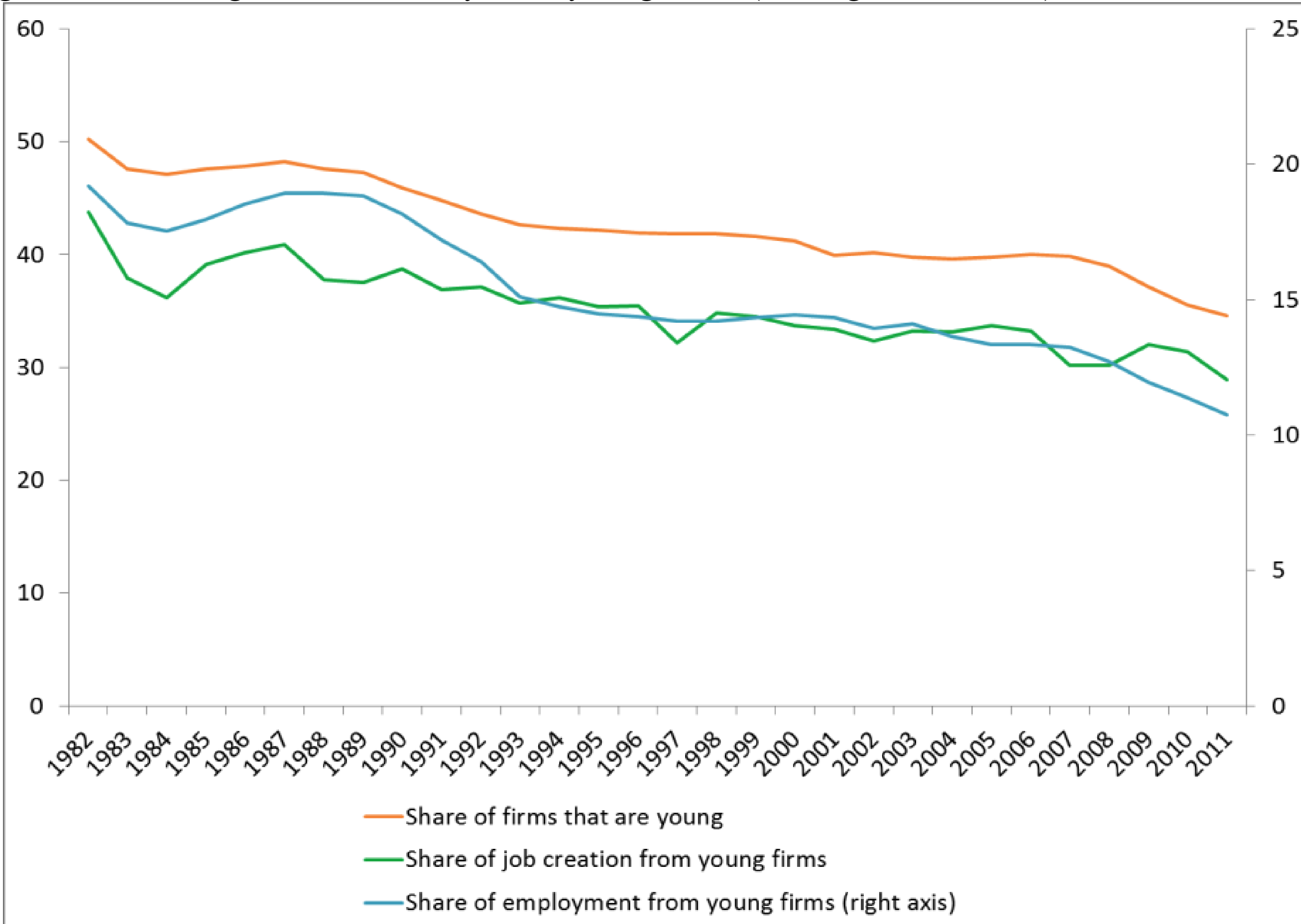
Notes: Author calculations from the U.S. Census Bureau's Business Dynamics Statistics. Filter is Hodrick-Prescott with multiplier 400. Vertical axis does not begin at zero.

Figure 2: Annual startup rate and average startup size, 1980-2011



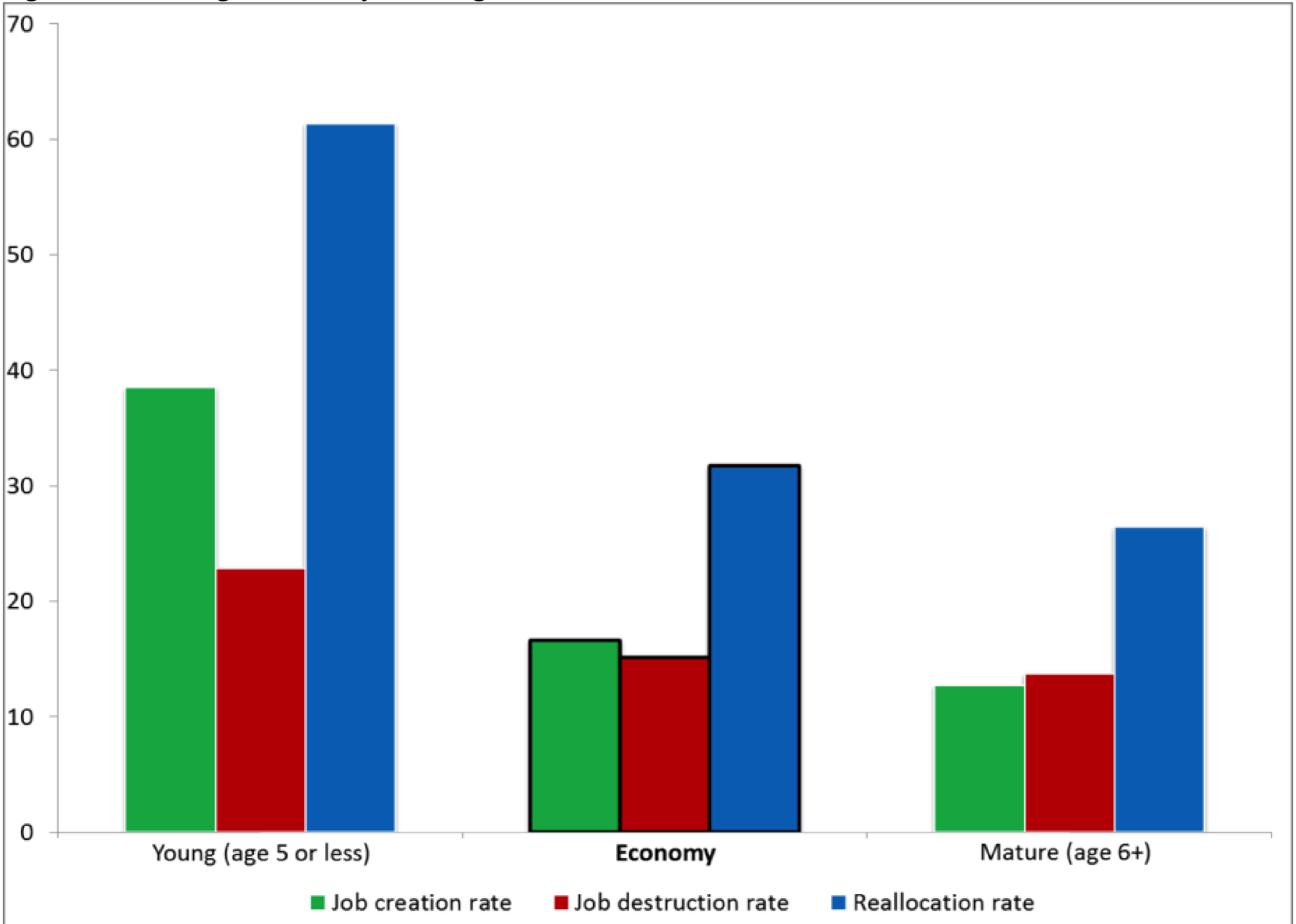
Notes: Author calculations from the U.S. Census Bureau's Business Dynamics Statistics. Left vertical axis does not begin at zero.

Figure 3: Declining share of activity from young firms (firm age five or less)



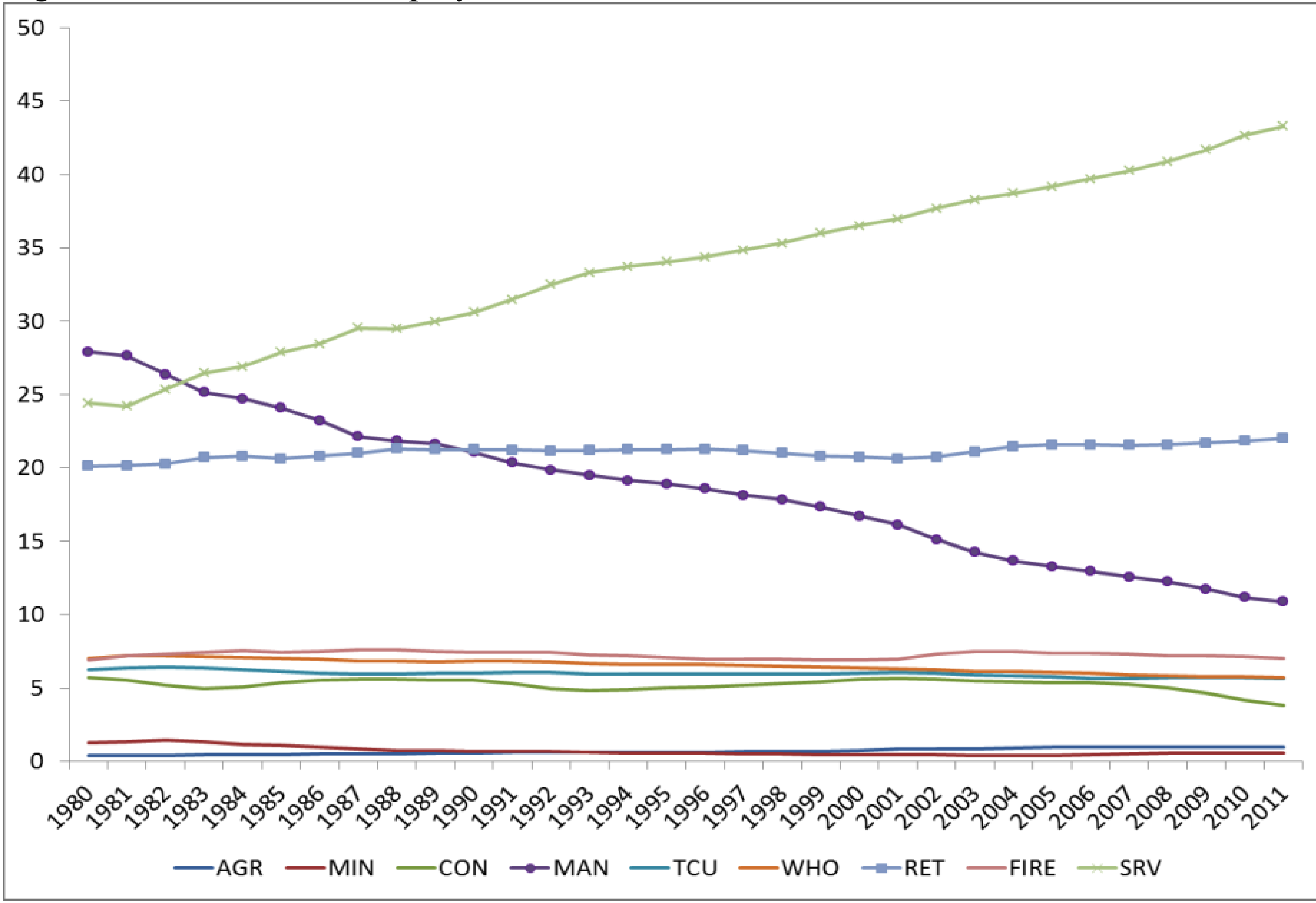
Notes: Author calculations from the U.S. Census Bureau's Business Dynamics Statistics. Employment shares in each period based on the average of employment in period t-1 and t (the denominator of the DHS growth rate).

Figure 4: Average flows by firm age, 1982-2011



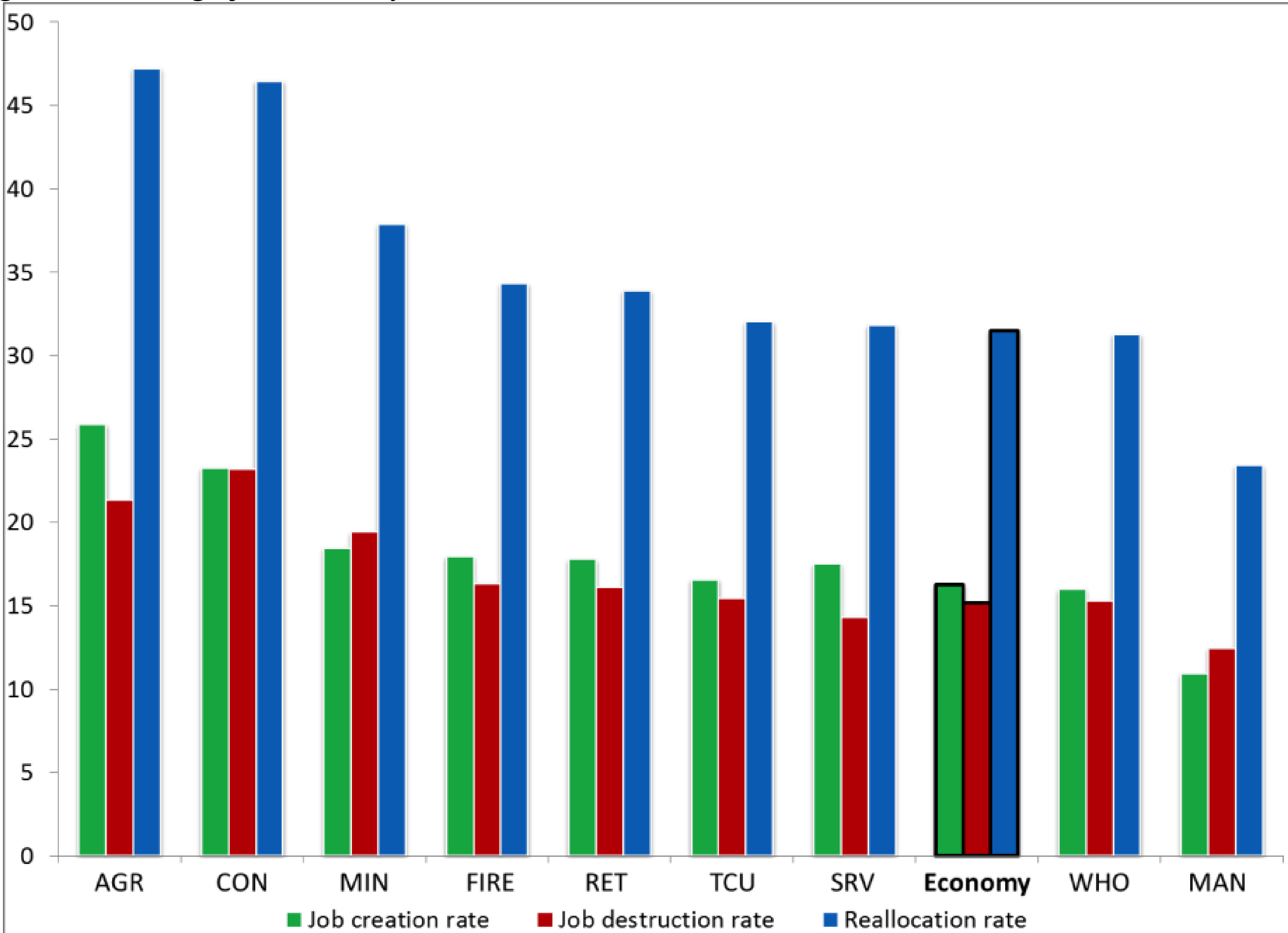
Notes: Author calculations from the U.S. Census Bureau's Business Dynamics Statistics.

Figure 5: Sector share of employment, 1980-2011



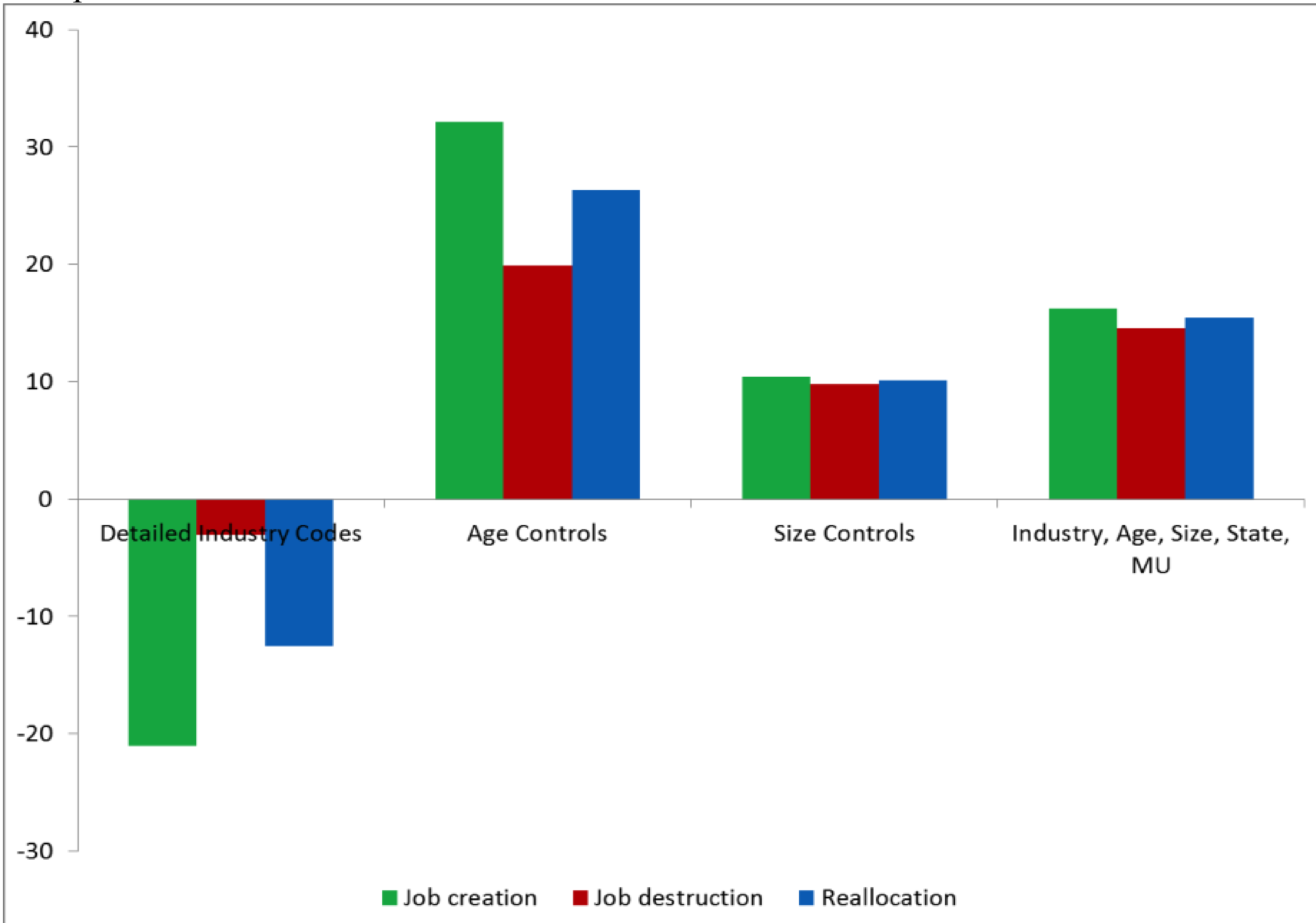
Notes: Author calculations from the U.S. Census Bureau's Business Dynamics Statistics. Broad sectors are on SIC basis. AGR= Agricultural Services, MIN=Mining, CON=Construction, MAN=Manufacturing, TCU=Transportation, Communication and Utilities, WHO=Wholesale Trade, RET=Retail Trade, FIRE = Finance, Insurance and Real Estate, and SRV=Services.

Figure 6: Average job flows by sector, 1980-2011



Notes: Author calculations from the U.S. Census Bureau's Business Dynamics Statistics. Sector definitions from SIC. See notes from Figure 5 for details on sectoral abbreviations.

Figure 9: Percent of decline in job flows from 1987/89 to 2004/06 (averages) accounted for by composition effects



Notes: Author calculations from the U.S. Census Bureau's Longitudinal Business Database. See text for details of the decomposition used to generate these calculations.

NUTS AND BOLTS oF PRODUCTIVITY MEASUREMENT

Measurement of Plant-level Productivity

$$tfp_i = y_i - \alpha_l l_i - \alpha_k k_i - \alpha_m m_i - \alpha_e e_t$$

All variables in logs, difficult measurement Issues on outputs and inputs and factor elasticities

Typical to assume Cobb-Douglass or to have Divisia index approach approximation

Measurement issues

- Factor inputs:
  - Labor quality
  - Capital stock (book value vs. perpetual inventory)
- Factor elasticities:
  - Cost shares, estimated elasticities using OLS, IV, proxy methods
  - All typically estimate factor elasticities at the industry level
    - Time invariant with estimated approach typically given Cobb-Douglass assumptions
  - Estimates vary in literature but measures of TFP highly correlated across these methods. Other issues (below) appear to matter more.
- Plant-level heterogeneity in output and input prices
- Plant-level heterogeneity in factor elasticities

More Basic Measures of Productivity Are Often Used

- Labor productivity Measures at the Establishment (or Firm level)
  - Real Value Added Per Worker

$$RLP_{et} = (VA_{et} / TE_{et}) = (Y_{et} - M_{et}) / TE_{et}$$

Where Y_{et} = Real Gross Output

M_{et}= Real Materials (including energy)

Te_{et}= Total Employment

Use detailed industry output and material price deflators

Often best available measure is real gross output per worker – comparable within industries

Example of proxy method

$$y_{jt} = \beta_0 + \beta_k k_{jt} + \beta_a a_{jt} + \beta_l l_{jt} + \omega_{jt} + \eta_{jt} \tag{24}$$

$$i_{jt} = i(k_{jt}, a_{jt}, \omega_{jt}, \Delta_t) = i_t(k_{jt}, a_{jt}, \omega_{jt}). \tag{27}$$

$$\omega_{jt} = h_t(k_{jt}, a_{jt}, i_{jt}). \tag{28}$$

$$y_{jt} = \beta_0 + \beta_k k_{jt} + \beta_a a_{jt} + \beta_l l_{jt} + h_t(k_{jt}, a_{jt}, i_{jt}) + \eta_{jt}. \tag{29}$$

$$y_{jt} - \beta_l l_{jt} = \beta_0 + \beta_k k_{jt} + \beta_a a_{jt} + \omega_{jt} + \eta_{jt}. \tag{33}$$

$$\begin{aligned} y_{jt} &- \beta_l l_{jt} \\ &= \beta_0 + \beta_k k_{jt} + \beta_a a_{jt} + g(\omega_{jt-1}) + \xi_{jt} + \eta_{jt} && \text{(34a)} \\ &= \beta_0 + \beta_k k_{jt} + \beta_a a_{jt} + g(\phi_{jt-1} - \beta_0 - \beta_k k_{jt-1} - \beta_a a_{jt-1}) + \xi_{jt} + \eta_{jt} \\ &= \beta_k k_{jt} + \beta_a a_{jt} + \tilde{g}(\phi_{jt-1} - \beta_k k_{jt-1} - \beta_a a_{jt-1}) + \xi_{jt} + \eta_{jt}, && \text{(34b)} \end{aligned}$$

Depends critically on the invertibility amongst other assumptions

$$Y = AK^{\alpha}L^{1-\alpha}$$

$$Y = \frac{D^{\varepsilon-1}}{P^{\varepsilon}}$$

$$\frac{rK}{wL} = \frac{\alpha}{1-\alpha}$$

$$APK = \frac{PY}{K} = \frac{\varepsilon}{\varepsilon-1}\frac{r}{\alpha}$$

$$APL = \frac{PY}{L} = \frac{\varepsilon}{\varepsilon-1}\frac{w}{1-\alpha}$$

$$TFPR = PA = \frac{\varepsilon}{\varepsilon-1}\left(\frac{W}{1-\alpha}\right)^{1-\alpha}\left(\frac{r}{\alpha}\right)^{\alpha}$$

$$TFPQ = A$$

Cobb-Douglas Technology, CRS
Isoelastic Demand, No Frictions,
Price takers in factor markets

No dispersion in factor cost share ratio, Revenue average product of capital, revenue average product of labor, TFPR

Even though there is dispersion
In TFPQ

Why is there so much dispersion in productivity across businesses in narrowly defined sectors?

- Background facts:
  - Interquartile range of log of Revenue TFP (TFPR) is 0.29
  - Interquartile range of log of Revenue Labor Productivity (RLP) is 0.65
  - Dispersion in TFPQ, TFPR, and output price within narrow product classes (7-digit) in U.S. (Source: FHS (2008)):
    - Std. Dev of log(TFPQ) is: 0.26
    - Std. Dev of log(TFPR) is: 0.22
    - Std. Dev of log(RLP) is: 0.65
    - Std. Dev of log(P) is: 0.18
    - Std. Dev of log(Q) is: 1.05
    - Corr(log(TFPQ),log(P)) is: -0.54
    - Corr(log(TFPQ),log(Q)) is: 0.28
    - Corr(log(TFPQ),log(TFPR)) is: 0.75
    - Corr(log(TFPQ),log(RLP)) is: 0.56

Frictions + Distortions

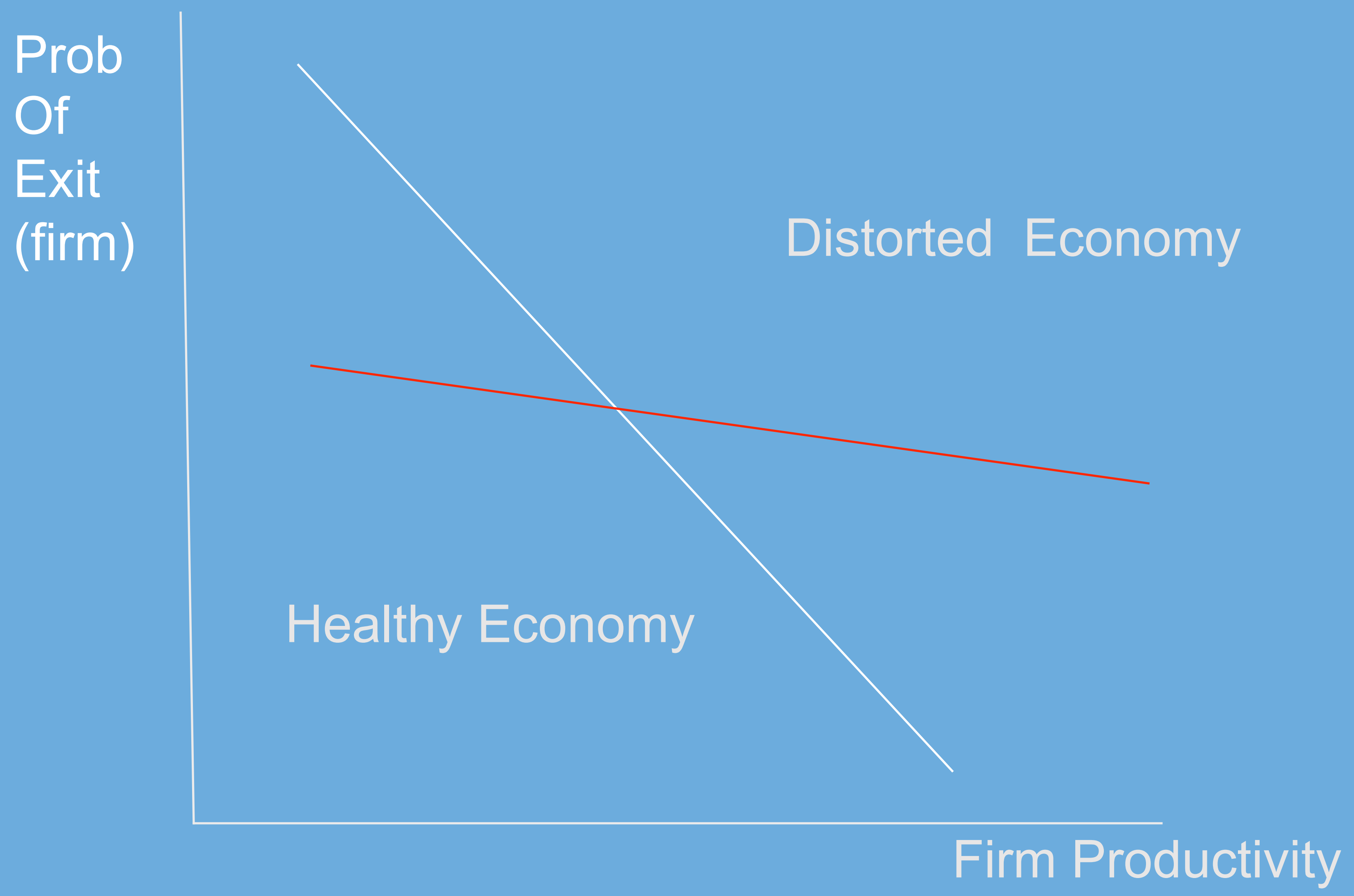
- Costs of Entry (and exit)
  - Including costs of entering new markets
  - Hopenhayn (1992), Melitz (2003), Melitz and Ottaviano (2005)
- Learning (initial conditions and after changing products/processes)
  - Jovanovic (1982) and Ericson and Pakes (1998)
  - Experimentation
- Adjustment costs for factors of production (capital, labor, intangible capital)
  - Convex vs. Nonconvex
- Economies of scope and control
- Product Differentiation:
  - Horizontal (e.g., spatial) vs. Vertical
- Output and input price dispersion and determination
- Imperfections in product, labor, capital, credit markets
- Distortions to all of the above + market institutions
  - Idiosyncratic distortions as in Banerjee and Duflo (2003), Restuccia and Rogerson (2008), Hsieh and Klenow (2009), Bartelsman, Haltiwanger and Scarpetta (2013)

What frictions matter the most?

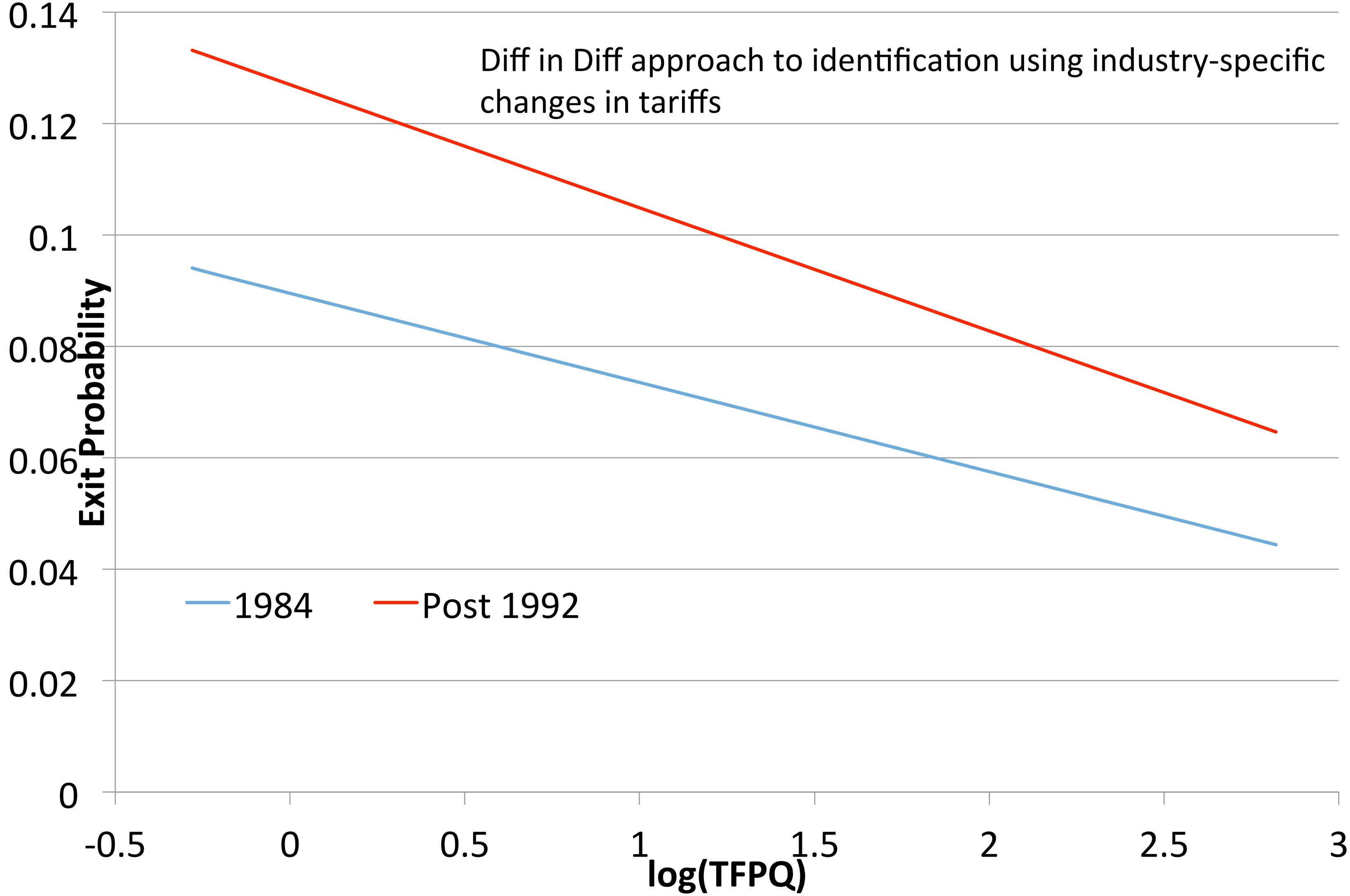
- Many studies showing evidence of entry costs, labor adjustment costs, capital adjustment costs, trade costs, product differentiation, and so on.
- Many open questions and issues:
  - Not practical to include all frictions in all models – but caution about identification since we are all using same data
  - How do frictions vary across advanced vs. emerging vs. transition?
- Important to distinguish between those frictions that yield some plants persistently higher productivity than others as opposed to adjustment dynamics

Lots of margins for distortions…

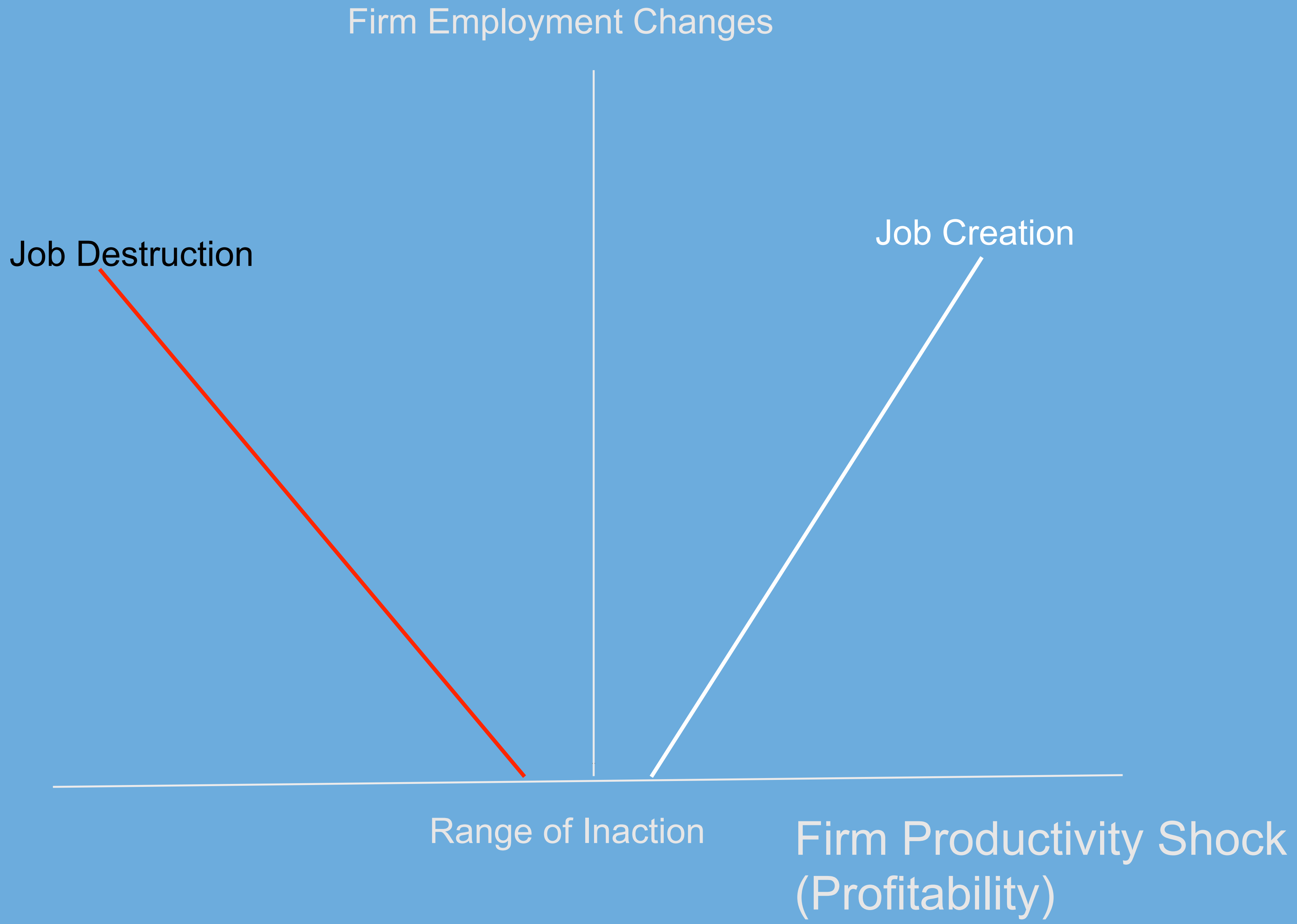
- Cross sectional misallocation
- Dynamic distortions:
  - Startups
  - Post-entry up or out dynamic
  - Creative Destruction
- Secular vs. Cyclical Distortions

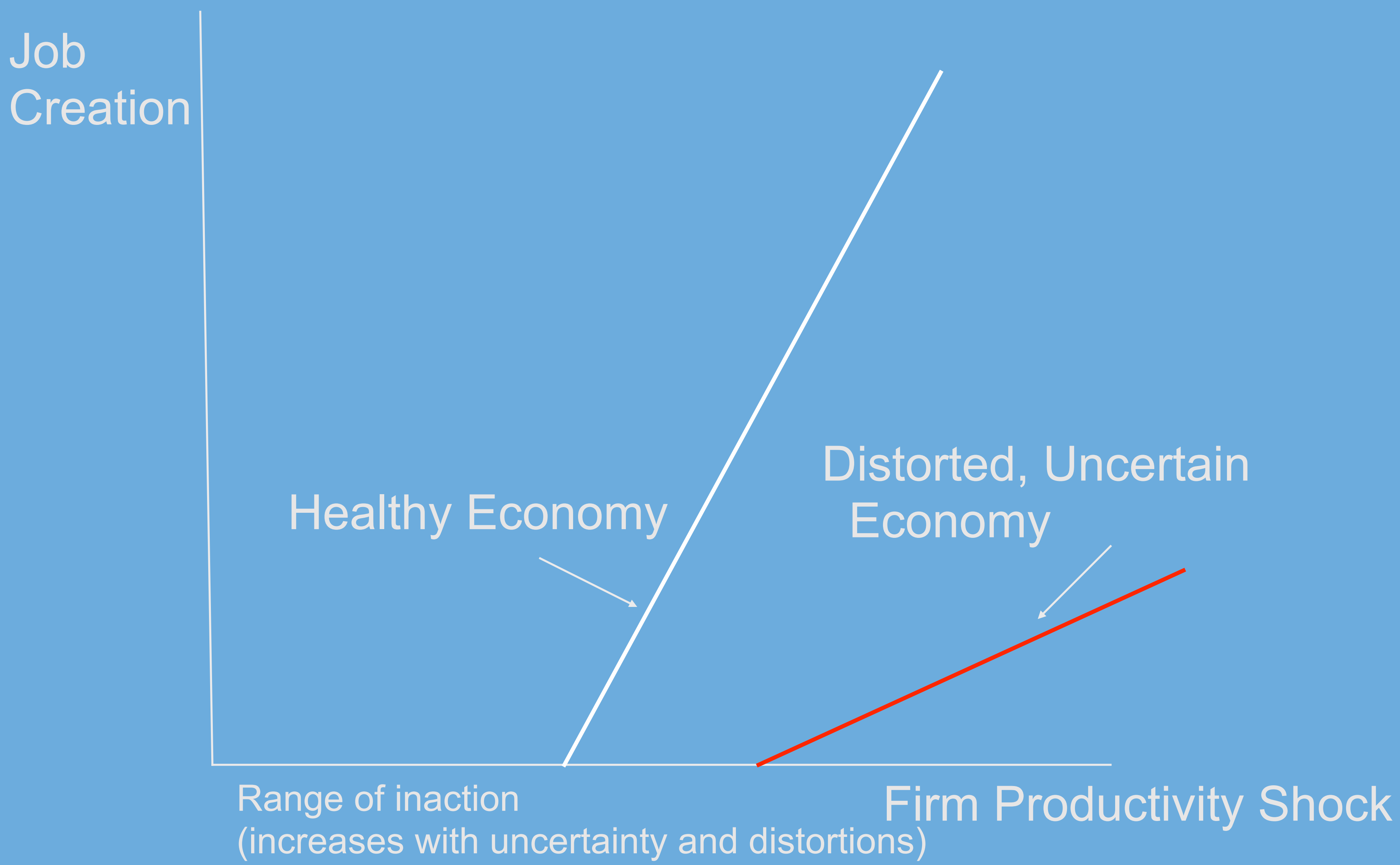

Prob
Of
Exit
(firm)
Distorted Economy
Healthy Economy
Firm Productivity

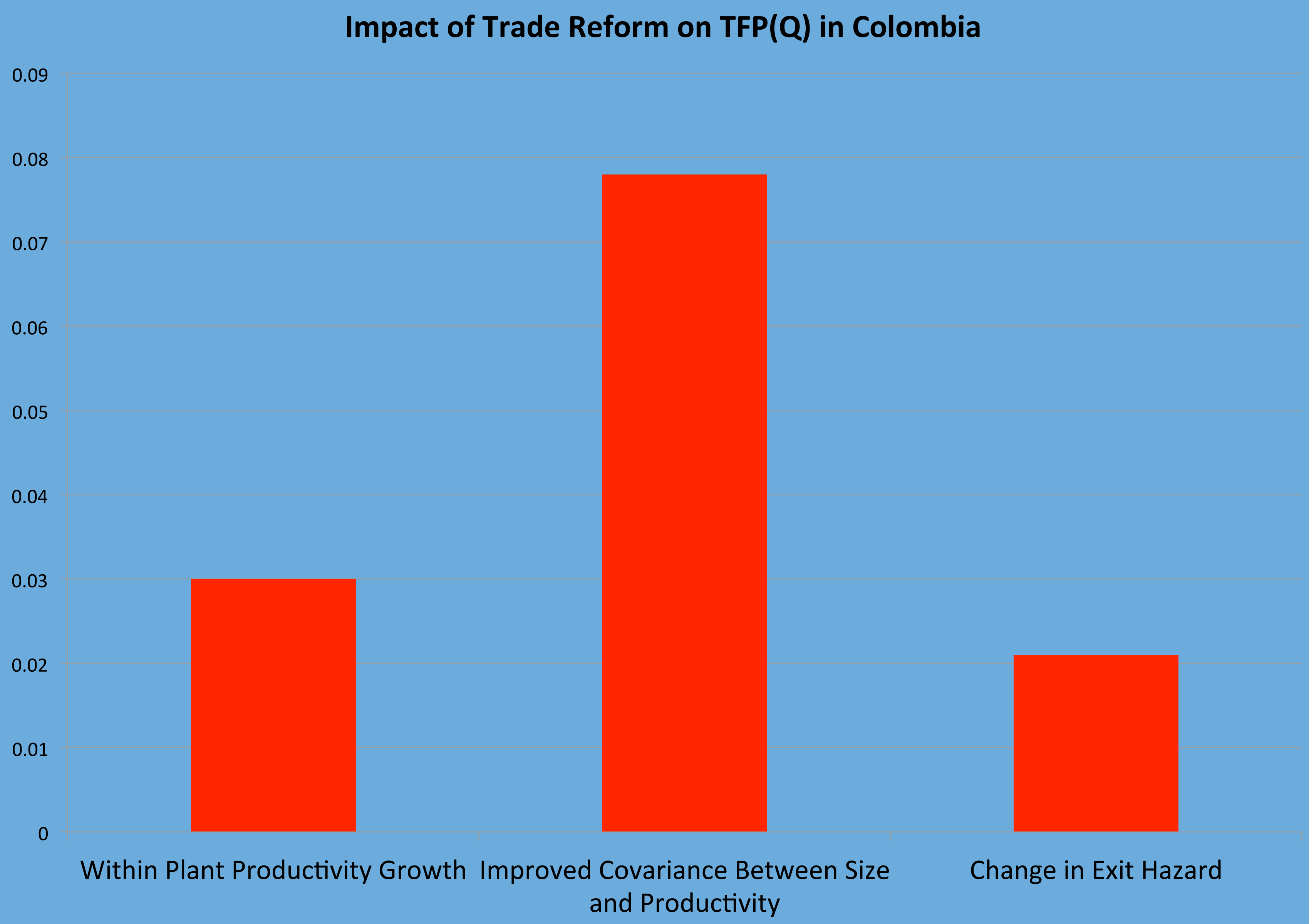
Impact of Trade Reform on Plant Exit Hazard in Colombia



Source: Eslava, Haltiwanger, Kugler and Kugler (2012)


Firm Employment Changes
Job Destruction
Job Creation
Range of Inaction
Firm Productivity Shock
(Profitability)


Job
Creation
Healthy Economy
Distorted, Uncertain
Economy
Range of inaction
(increases with uncertainty and distortions)
Firm Productivity Shock



Source: Eslava, Haltiwanger, Kugler and Kugler (2012)

Taking Stock

- High pace of churning of businesses within narrowly defined industries
- Startups and young businesses play an important role in these dynamics
- Up or out dynamics
- These dynamics connected to productivity (and demand) dynamics at the micro level
- Identifying the frictions and how they vary across industry, time, and country ongoing activity
- But what about before entry?

How Do We measure the CONTRIBUTION OF REALLOCATION?

Size/productivity relationship within industries

$$\Omega_t = \sum_i s_{it}\omega_{it}$$

$$= (1/N_t)\sum_i \omega_{it} + \sum_i (s_{it} - (1/N_t)\sum_i s_{it})(\omega_{it} - (1/N_t)\sum_i \omega_{it}))$$

Olley and Pakes (1996) decomposition

$$\Delta\,\Omega_t = \sum_i s_{it}\omega_{it} - \sum_i s_{it-1}\omega_{it-1}$$

$$= \sum_{i\in C} \overline{s_{it}}\Delta\omega_{it} + \sum_{i\in C} \Delta s_{it}\overline{(\omega_{it}} - \overline{\Omega_t}) + \sum_{i\in N} s_{it}\left(\omega_{it} - \overline{\Omega_t}\right) - \sum_{i\in X} s_{it-1}\left(\omega_{it-1} - \overline{\Omega_t}\right)$$

$$= within \quad + \quad reallocation \quad + \quad entry \quad - \quad exit$$

Modified Baily, Hulten and Campbell (1992) and Griliches and Regev (1995) decomposition

Comments on Decomposition in Literature

- Some questions about how to interpret industry-level index defined in this manner
  - Typical check (e.g., BHC and FHK) to see how this index performs relative to standard aggregate ***industry*** measures
    - Common result – magnitudes very similar and correlations high in most studies
    - Cautions:
      - These measures very sensitive to measurement error since depend on measuring within industry productivity (log) level dispersion accurately
      - Not appropriate for decompositions that exploit between industry variation (measurement and index problems)
  - Standard decomposition summarizes changes in activity weighted micro distribution
  - Decompositions more closely tied to aggregate welfare and productivity have been developed (Petrin and Levinsohn (2008), Basu and Fernald (2002)
  - Alternatively, these decompositions can be used as moments to match in a calibration or indirect inference approach (see, e.g., Bartelsman, Haltiwanger and Scarpetta (2009)

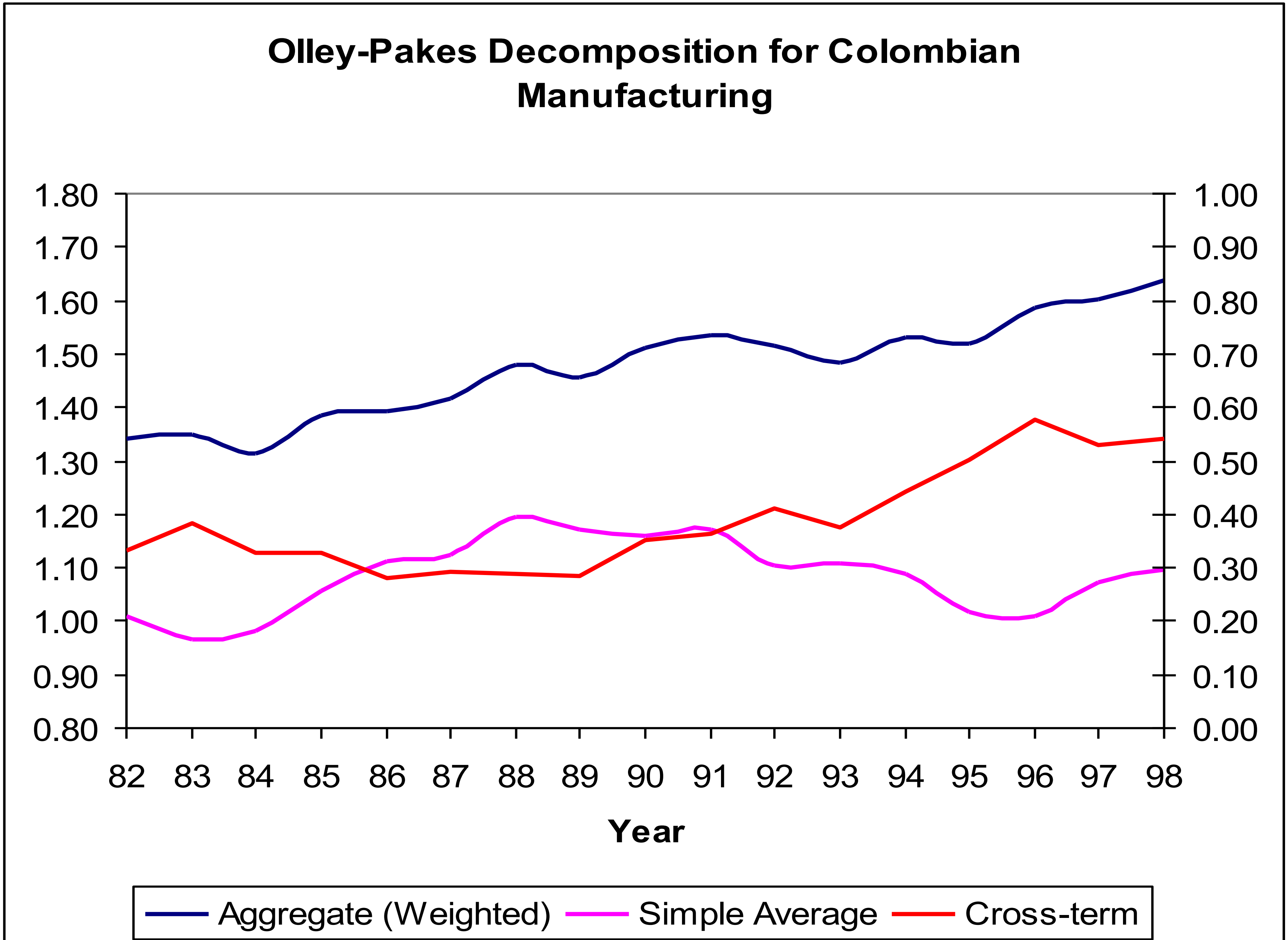
Olley and Pakes (1996) results for Telecommunications equipment

TABLE XI

DECOMPOSITION OF PRODUCTIVITY[a]
(EQUATION (16))

Year	p_t	$\bar{p}_t$	$\Sigma_i \Delta s_{it} \Delta p_{it}$	$\rho(p_{it}, k_{it})$
1974	1.00	0.90	0.01	−0.07
1975	0.72	0.66	0.06	−0.11
1976	0.77	0.69	0.07	−0.12
1977	0.75	0.72	0.03	−0.09
1978	0.92	0.80	0.12	−0.05
1979	0.95	0.84	0.12	−0.05
1980	1.12	0.84	0.28	−0.02
1981	1.11	0.76	0.35	0.02
1982	1.08	0.77	0.31	−0.01
1983	0.84	0.76	0.08	−0.07
1984	0.90	0.83	0.07	−0.09
1985	0.99	0.72	0.26	0.02
1986	0.92	0.72	0.20	0.03
1987	0.97	0.66	0.32	0.10

[a] See text for details.



Source: Eslava et al. (2005)

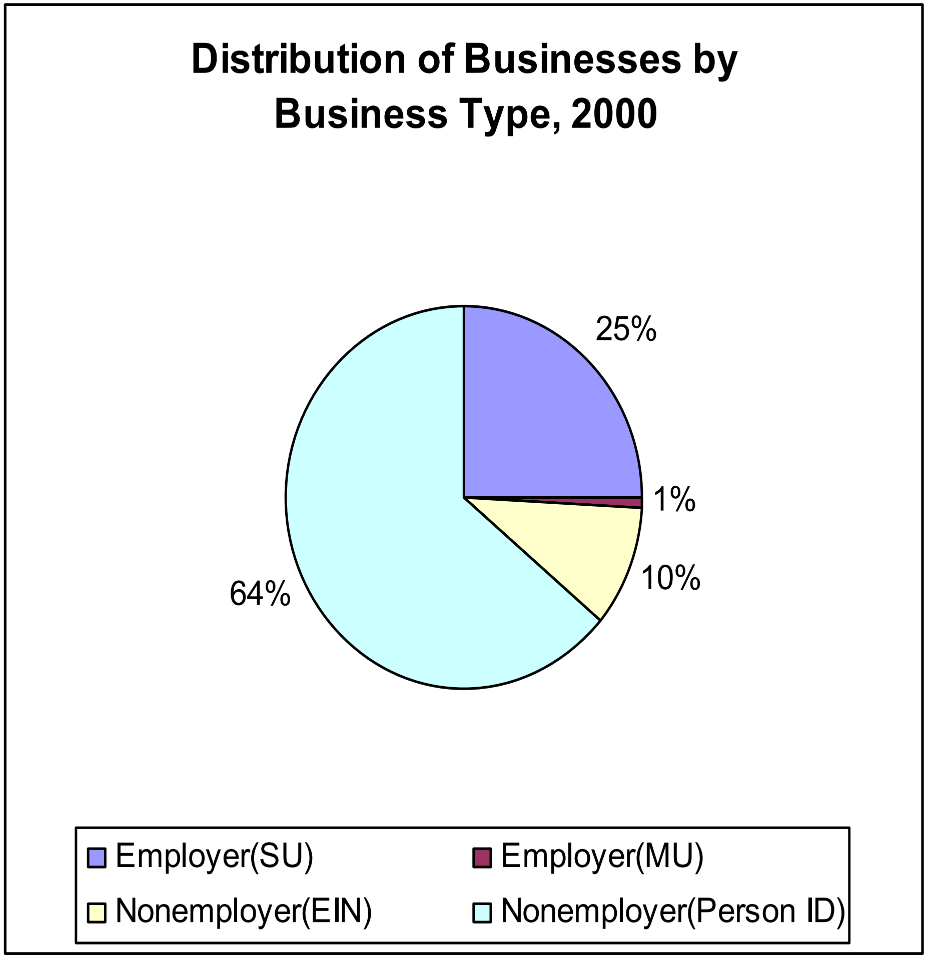

Olley Pakes Decomposition of Labor Productivity
(Average Industry)
China
Overall, Unweighted average
OP_gap
4.50
4.15
3.80
3.45
3.10
2.75
2.40
0.02
0.00
-0.02
-0.04
-0.06
-0.08
-0.10
-0.12
-0.14
-0.16
-0.18
-0.20
1998
1999
2000
2001
2002
2003
2004
2005
Year
Unweighted Average
Overall
OP_gap

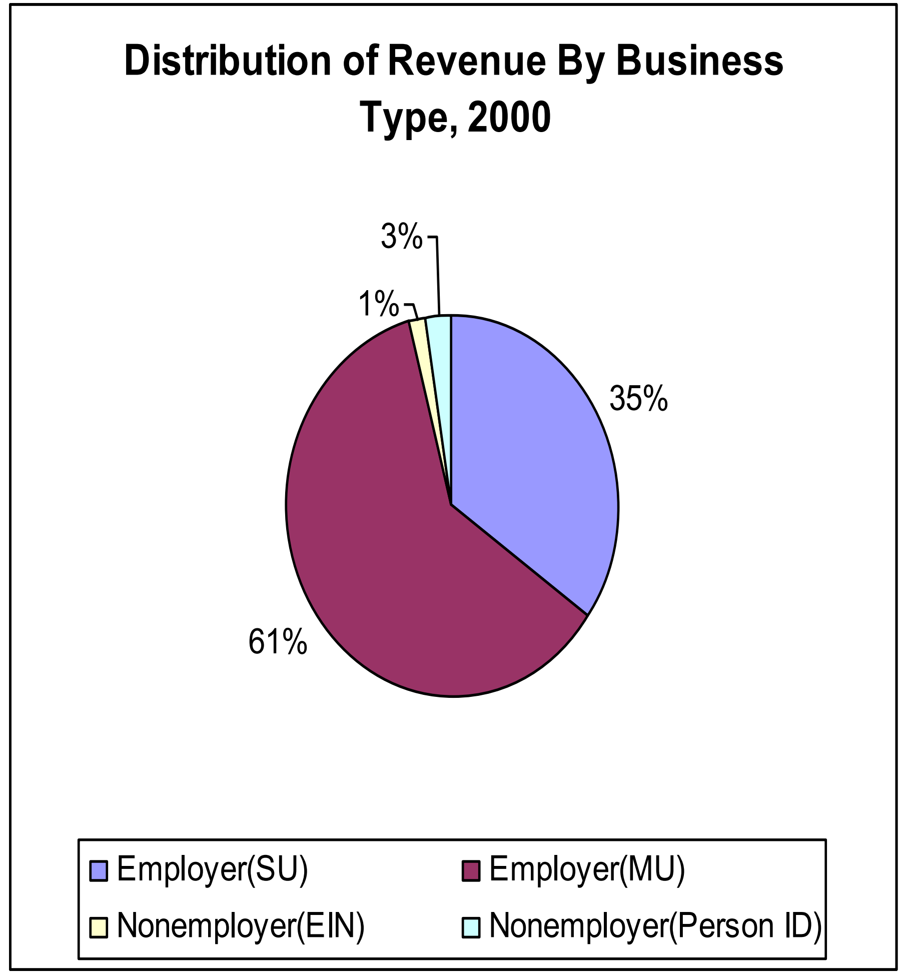
Pre-Entry History of entrepreneurs

"Before" Entry....

- Entrepreneurial dynamics starts at micro business level
- Entrepreneurs start with an idea – often while employed elsewhere
- New longitudinal databases at U.S. Census Bureau tracking this process
  - ILBD: Nonemployers (e.g., sole props without employees) + Employers
  - LEHD/SED: Tracking transitions from W&S jobs to self-employed jobs

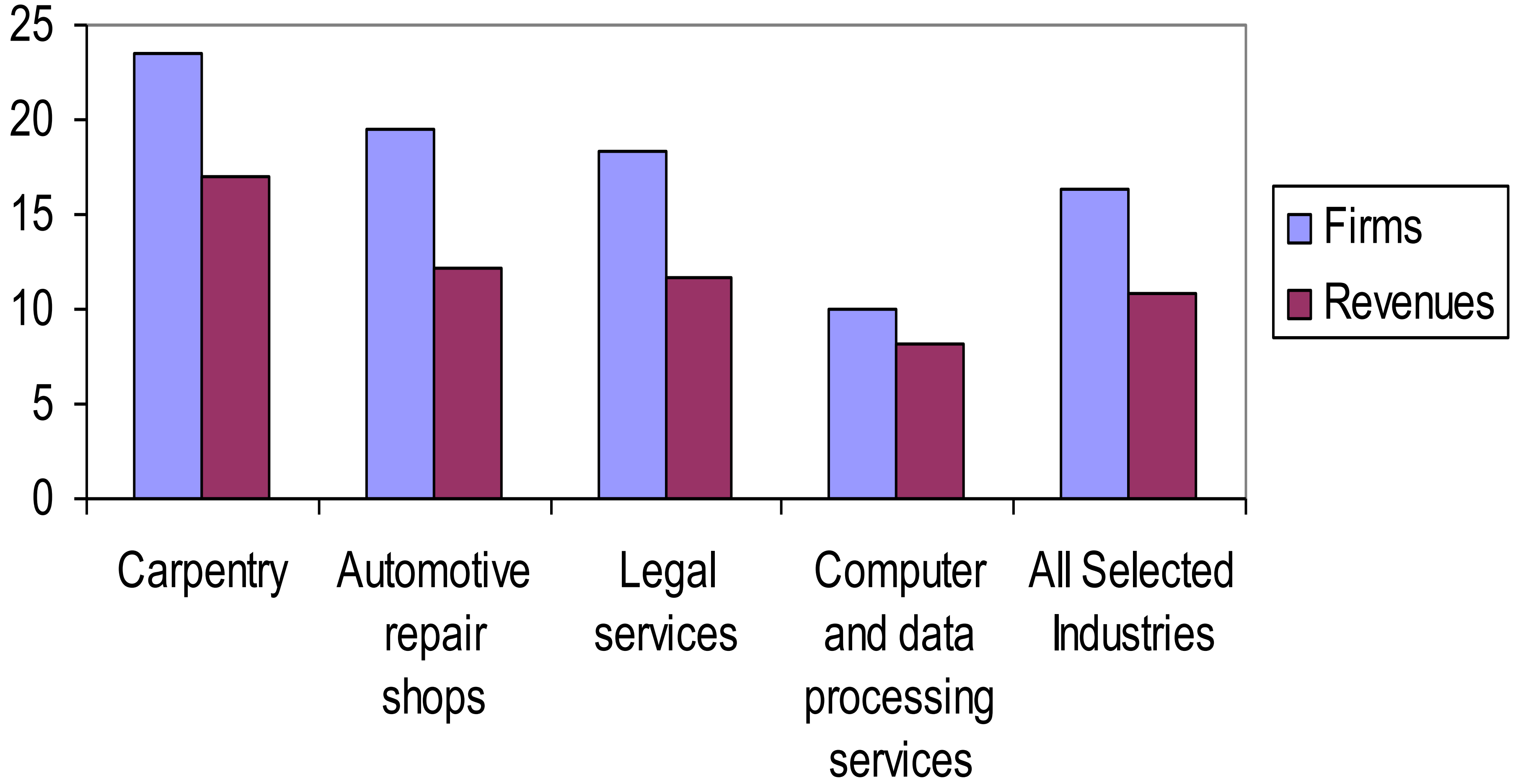
Micro Businesses constitute a large share of businesses and a small share of revenue…





Source: Davis et. al. (2008)

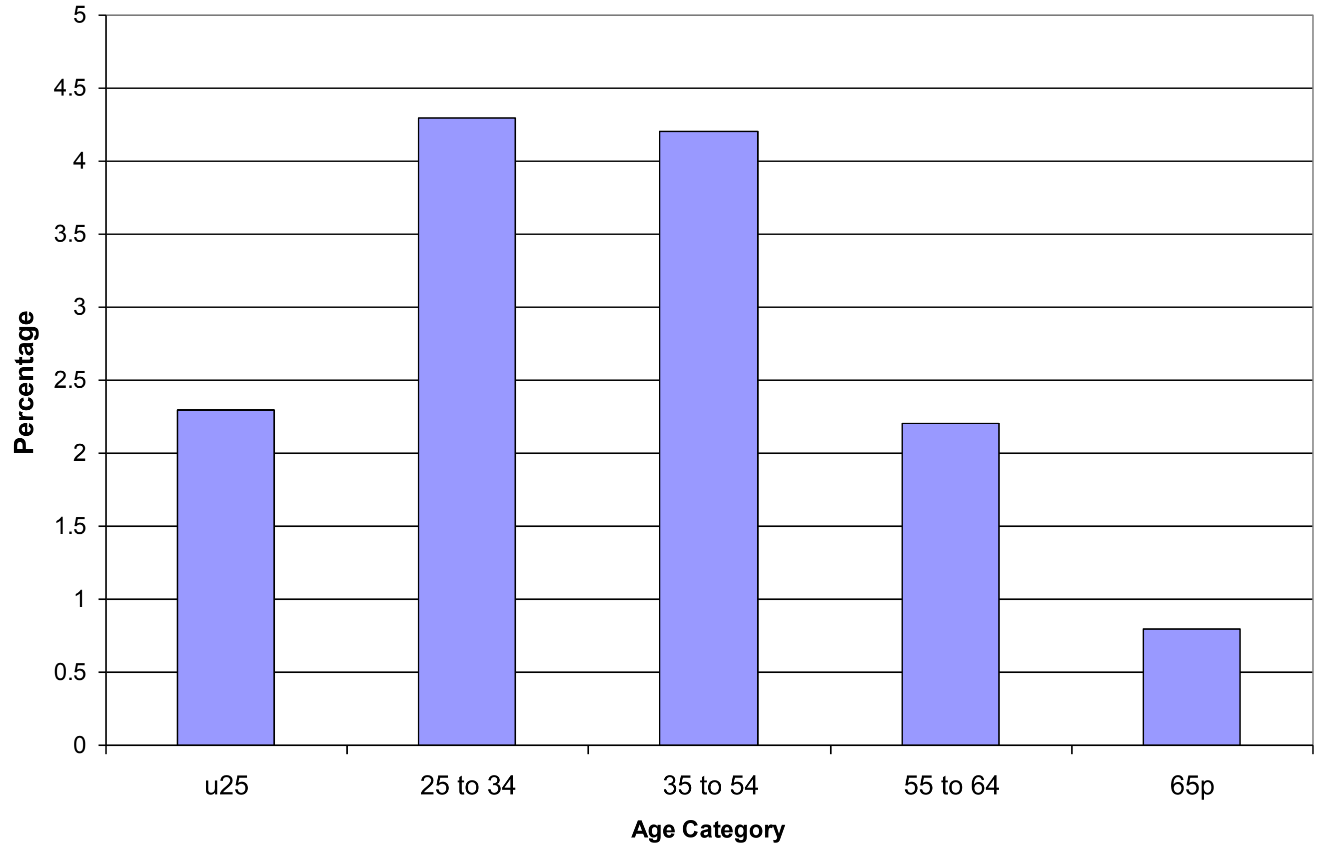
Shares of New Employer Businesses in 1997 with Pre-History as Nonemployer Businesses



Source: Davis et al. (2008)

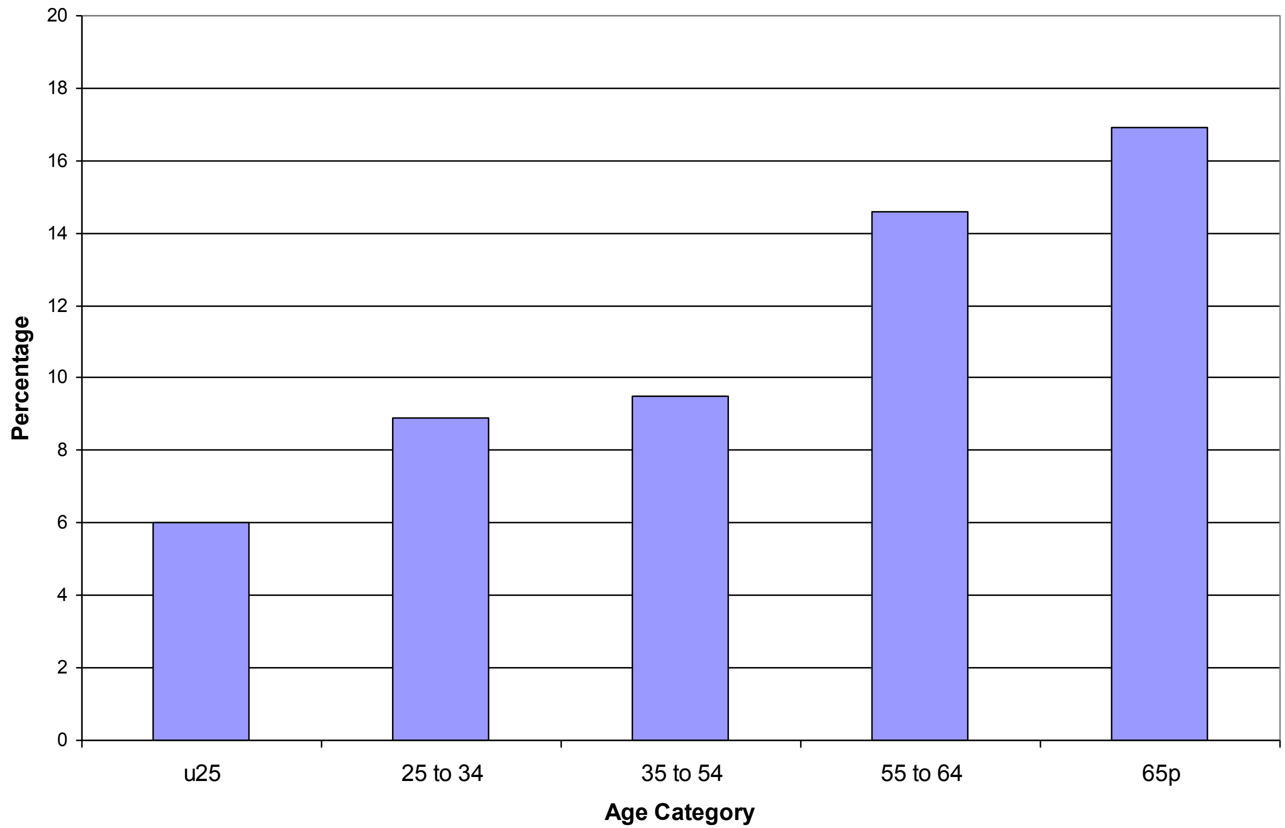
Propensity to Diversify in Labor Market Varies in Important Ways Across Worker Life Cycle

Percent of 1992 Wage and Salary Earners moving to Partial Self-Employment by 1997: By Age Category

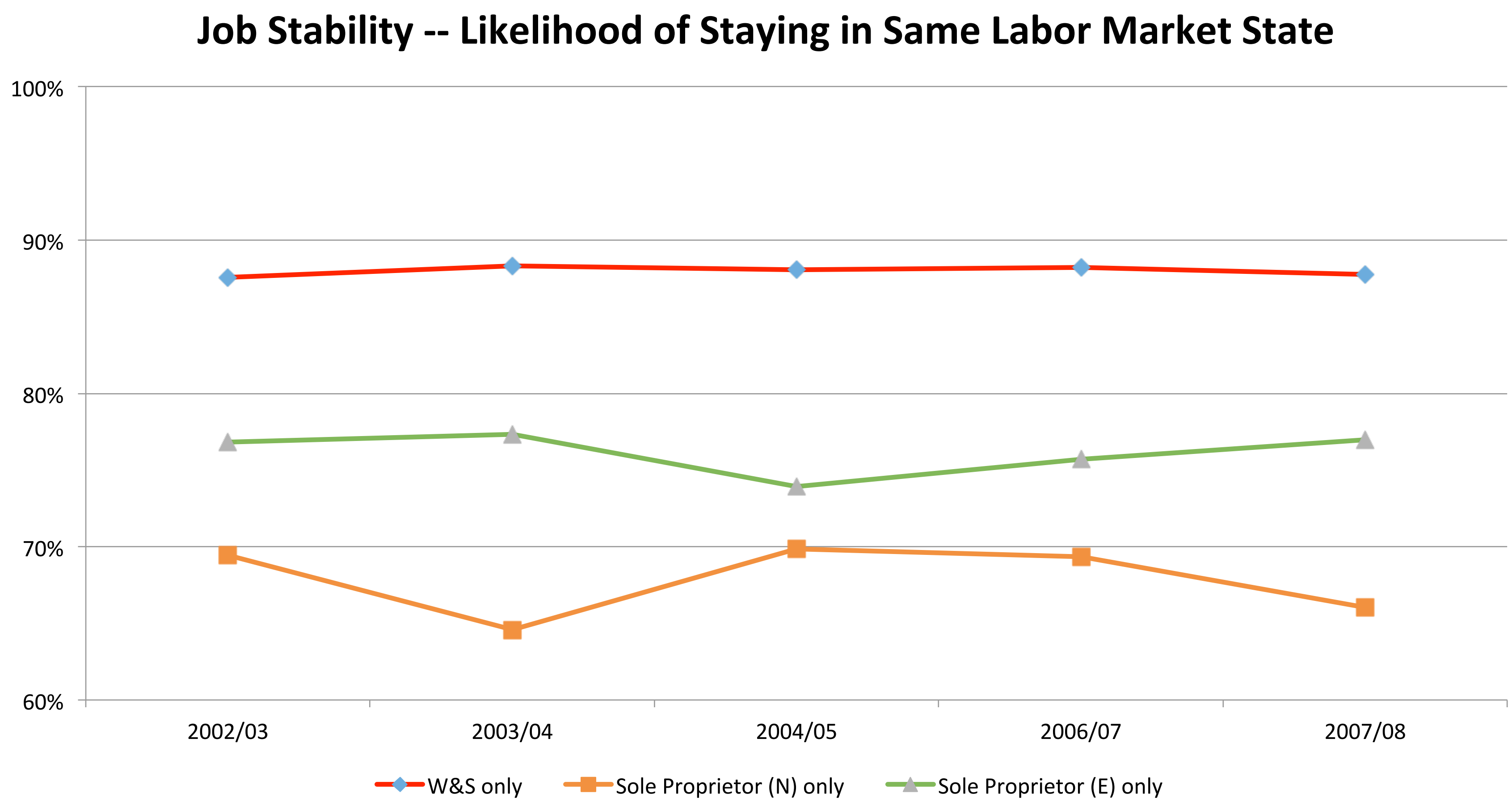


Propensity to Diversify in Labor Market Varies in Important Ways Across Worker Life Cycle

Percent of 1992 Partially Self-Employed moving to Full Self-Employment by 1997: By Age Category



Small Businesses With and Without Paid Employees Differ in Fundamental Ways



Data

- Tracking U.S. Business Dynamics
  - The Longitudinal Business Database
    - 1975-2005 (08) – long time series permits analysis by firm age
    - Private Non Farm Economy
    - Establishment level with Firm identifiers
    - High quality establishment links to identify entry/exit
      - Need both firm and establishment level data to get dynamics right
    - Firm Size: constructed by aggregating employment up to firm
    - Firm Age: constructed from age of oldest establishment at time of firm birth
    - Other: Payroll, Industry, Location (Lat/Lon possible)
    - Can be integrated with data from Economic Censuses and Annual Surveys as well as external data (COMPUSTAT, Venture Capital, Private Equity)

Micro Productivity Data in U.S.

- Manufacturing:
  - Annual Survey of Manufactures and Census of Manufactures
    - Nominal revenue and expenditures
    - Can construct measures of real outputs and inputs
    - Five year panel rotation so longitudinal analysis possible (but requires careful treatment of data)
    - Selected products have physical quantities
- Retail Trade
  - Census of Retail Trade
    - Nominal revenue so a gross output per store measure feasible

New data on micro businesses

- ILBD:
  - Tracks all nonemployer and employer businesses including transitions
- LEHD:
  - Tracks all employer-employee matches in U.S.
  - Can be integrated with ILBD
  - Enables tracking of transitions between W&S, an owner of nonemployer business and owner of employer business

Availability of data

- Public domain tabulations available at:

http://www.ces.census.gov/index.php/bds/bds_home

- Census NSF/RDC access at:

http://www.ces.census.gov/index.php/ces/researchguidelines

- Sensitive data:
  - Must work in enclave (NBER, NYCRDC, Washington, D.C., Chicago Fed, Duke, UCLA, UC-Berkeley, Univ. of Michigan, Cornell, Stanford , Univ. of Minn., Atlanta, …)
  - Predominant purpose must benefit U.S. Census

Extra Slides on Firm Dynamics model

Standard Heterogeneous-Producer Industry Models

The Workhorse:

- Producers i differ in a profitability component ω_i, usually taken to represent costs/productivity

- Profits depend on ω_i and industry state S: $\pi_i = \pi_i(\omega_i, S)$ $\quad \omega_i \sim G(\omega)$

- There is some critical ω^* such that producers with $\omega_i < \omega^*$ have NPVs below outside option and therefore exit the industry

- Industry state S typically depends on endogenously determined distribution of ω_i among producers (add'l free entry assumption)

- Examples: Jovanovic (1982), Hopenhayn (1992), Melitz (2003), Asplund and Nocke (2007)

Closely Related Issue – Size Distribution of Activity

- $\pi_i = \pi_i(\omega_i, S)$ has curvature either from decreasing returns (e.g., Lucas (1978)) or product differentiation (e.g., Melitz (2003))
- Curvature pins down the size distribution of activity and permits studying the evolution of the size distribution of activity
- In healthy market economies, most productive plants are the largest – allocative efficiency
- Active literature attempting to explain cross country differences in productivity (e.g., Hsieh and Klenow (2009)) using distortions on this margin

Model: Melitz/Ottaviano (2005) and FHS (2008)

Industry is comprised of a continuum of producers of measure N.
Each produces a single variety (indexed by i) of industry product.
Representative consumer's utility function

$$U = y + \int_{i\in I}(\alpha+\delta_i)q_i di - \frac{1}{2}\eta\left(\int_{i\in I} q_i di\right)^2 - \frac{1}{2}\gamma\int_{i\in I} q_i^2 di$$

$$= y + \alpha\int_{i\in I} q_i di - \frac{1}{2}\left(\eta+\frac{\gamma}{N}\right)\left(\int_{i\in I} q_i di\right)^2 + \int_{i\in I}\delta_i q_i di - \frac{1}{2}\gamma\int_{i\in I}(q_i-\overline{q})^2 di$$

$\alpha > 0$, $\eta > 0$, and $\gamma \geq 0$.
y = numeraire good
δ_i = variety-specific, mean-zero taste shifter
q_i = quantity of good i consumed

$$\overline{q} = \frac{1}{N}\int_{i\in I} q_i di$$

The implied demand curve:

$$q_i = \frac{1}{\eta N+\gamma}\alpha - \frac{1}{\gamma}\frac{\eta N}{\eta N+\gamma}\overline{\delta} + \frac{1}{\gamma}\frac{\eta N}{\eta N+\gamma}\overline{p} + \frac{1}{\gamma}\delta_i - \frac{1}{\gamma}p_i$$

Model: Supply

Production Function: $q_i = \omega_i x_i$

Producers face (potentially idiosyncratic) factor price w_i

$\Rightarrow$ marginal cost = w_i/ω_i

Profits:

$$\pi_i = \left(\frac{1}{\eta N + \gamma}\alpha - \frac{1}{\gamma}\frac{\eta N}{\eta N + \gamma}\bar{\delta} + \frac{1}{\gamma}\frac{\eta N}{\eta N + \gamma}\bar{p} + \frac{1}{\gamma}\delta_i - \frac{1}{\gamma}p_i \right)\left(p_i - \frac{w_i}{\omega_i} \right)$$

Profit-maximizing price (constant marginal cost c_i):

$$p_i = \frac{1}{2}\frac{\gamma}{\eta N + \gamma}\alpha - \frac{1}{2}\frac{\eta N}{\eta N + \gamma}\bar{\delta} + \frac{1}{2}\frac{\eta N}{\eta N + \gamma}\bar{p} + \frac{1}{2}\delta_i + \frac{1}{2}\frac{w_i}{\omega_i}$$

Deviation from industry-average price:

$$p_i - \bar{p} = \frac{1}{2}\left(\delta_i - \bar{\delta}\right) + \frac{1}{2}\left(\frac{w_i}{\omega_i} - \overline{\left(\frac{w}{\omega}\right)} \right)$$

Maximized profits:

$$\pi_i = \frac{1}{4\gamma}\left(\frac{\gamma}{\eta N + \gamma}\alpha - \frac{\eta N}{\eta N + \gamma}\bar{\delta} + \frac{\eta N}{\eta N + \gamma}\bar{p} + \delta_i - \frac{w_i}{\omega_i} \right)^2$$

Model: Equilibrium

Equilibrium Condition 1: The marginal producer in the industry makes zero profits

Define "profitability index" $\phi_i \equiv \delta_i - \frac{w_i}{\omega_i}$. Then marginal producer has index equal to:

$$\phi^* = -\frac{\gamma}{\eta N + \gamma}\alpha + \frac{\eta N}{\eta N + \gamma}\overline{\delta} - \frac{\eta N}{\eta N + \gamma}\overline{p}$$

Profits can be rewritten in terms of this marginal profitability level

$$\pi_i = \frac{1}{4\gamma}(\phi_i - \phi^*)^2$$

Profits increase in demand (δ_i) and efficiency (ω_i), decrease in factor price (w_i)

Equilibrium Condition 2: Potential entrants decide whether to pay sunk entry cost s to learn δ_i, ω_i, w_i. Expected value of entry is 0.

$$V^e = \int_0^{w_u}\int_{\omega_l}^{\omega_u}\int_{\phi^*+\frac{w}{\omega}}^{\delta_e} \frac{1}{4\gamma}(\phi_i - \phi^*)^2 f(\delta, \omega, w)\, d\delta\, d\omega\, dw - s = 0$$

Selection effect:

- Only high-profitability producers operate in equilibrium
- Low types exit

Sunk costs, market power and dispersion:

- Sunk costs make entry costly
- Curvature yields equilibrium size distribution

Many models of selection also include fixed costs of operating each period

Model: Empirical Implications

Output-based productivity:

$$TFPQ_i = \frac{q_i}{x_i} = \frac{\omega_i x_i}{x_i} = \omega_i$$

Revenue-based productivity (literature standard):

$$TFPR_i = \frac{p_i q_i}{x_i} = p_i \omega_i = \frac{1}{2}\frac{\gamma\alpha}{\eta N + \gamma}\omega_i + \frac{1}{2}\frac{\eta N}{\eta N + \gamma}\left(\bar{p} - \bar{\delta}\right)\omega_i + \frac{1}{2}\delta_i \omega_i + \frac{1}{2} w_i$$

Plant price deviation from industry deflator depends on both demand (enters positively into profits) and costs (enter negatively):

$$p_i - \bar{p} = \frac{1}{2}\left(\delta_i - \bar{\delta}\right) + \frac{1}{2}\left(\frac{w_i}{\omega_i} - \overline{\left(\frac{w}{\omega}\right)}\right)$$

Comparative Statics:

- $\frac{d\phi^*}{d\gamma} < 0$: Lower substitutability (higher γ) lowers ϕ^*
- $\frac{d\phi^*}{ds} < 0$: Higher sunk entry cost lowers ϕ^*

Start with Foster, Haltiwanger and Syverson (2008)

- Source data: Census of Manufactures
  - High quality coverage
  - Limited number of products with physical quantity data

Correlations								
Variables	Trad'l. Output	Revenue Output	Physical Output	Price	Trad'l. TFP	Revenue TFP	Physical TFP	Capital
Traditional Output	1.00							
Revenue Output	0.99	1.00						
Physical Output	0.98	0.99	1.00					
Price	-0.03	-0.03	-0.19	1.00				
Traditional TFP	0.19	0.18	0.15	0.13	1.00			
Revenue TFP	0.17	0.21	0.18	0.16	0.86	1.00		
Physical TFP	0.17	0.20	0.28	-0.54	0.64	0.75	1.00	
Capital	0.86	0.85	0.84	-0.04	0.00	-0.00	0.03	1.00
Standard Deviations								
Standard Deviations	1.03	1.03	1.05	0.18	0.21	0.22	0.26	1.14

Measuring Plant-Level Demand

Estimate product demand curves; plant-specific residual is idio. demand

$$\ln q_{it} = \alpha_o + \alpha_1 \ln p_{it} + \alpha_2 \ln(INCOME_{mt}) + \sum_t \alpha_t YEAR_t + \eta_{it}$$

q_{it}—physical output of plant *i* in year *t*
p_{it}—plant unit price
$INCOME_{mt}$—average income in the plant's local market *m*
$YEAR_t$—year dummy
η_{it}—plant-year disturbance term

Plant demand:

$$\hat{\delta}_{it} = \hat{\eta}_{it} + \hat{\alpha}_2 \ln(INCOME_{mt}) = \ln q_{it} - \hat{\alpha}_o - \hat{\alpha}_1 \ln p_{it} - \sum_t \hat{\alpha}_t YEAR_t$$

I.e., residual is plant quantity sold that can't be accounted for by unit price or local income differences

- Use $TFPQ_{it}$ to instrument for prices (captures production costs)

Product	IV Estimation			OLS Estimation	
	Price Coefficient (α_1)		Income Coefficient (α_2)	Price Coefficient (α_1)	Income Coefficient (α_2)
Boxes	-3.02		-0.03	-2.19	-0.03
	0.17	[0.61]	*0.02*	*0.12*	*0.02*
Bread	-3.09		0.12	-0.89	0.07
	0.42	[0.33]	*0.05*	*0.15*	*0.04*
Carbon Black	-0.52		-0.21	-0.57	-0.21
	0.38	[0.50]	*0.11*	*0.21*	*0.11*
Coffee	-3.63		0.22	-1.03	0.20
	0.98	[0.41]	*0.14*	*0.32*	*0.13*
Concrete	-5.93		0.13	-0.83	0.15
	0.36	[0.10]	*0.01*	*0.09*	*0.01*
Hardwood Flooring	-1.67		-0.20	-0.87	-0.24
	0.48	[0.61]	*0.18*	*0.47*	*0.18*
Gasoline	-1.42		0.23	-0.16	0.23
	2.72	[0.20]	*0.07*	*0.80*	*0.07*
Block Ice	-2.05		0.00	-0.63	0.16
	0.46	[0.32]	*0.11*	*0.20*	*0.07*
Processed Ice	-1.48		0.18	-0.70	0.16
	0.27	[0.37]	*0.03*	*0.13*	*0.03*
Plywood	-1.21		-0.23	-1.19	-0.23
	0.14	[0.89]	*0.10*	*0.13*	*0.10*
Sugar	-2.52		0.76	-1.04	0.72
	1.01	[0.15]	*0.13*	*0.55*	*0.12*

	Five-Year Horizon		Implied One-Year Persistence Rates	
Dependent Variable	Unweighted Regression	Weighted Regression	Unweighted Regression	Weighted Regression
Traditional TFP	0.249 *0.017*	0.316 *0.042*	0.757	0.794
Revenue TFP	0.277 *0.021*	0.316 *0.042*	0.774	0.794
Physical TFP	0.312 *0.019*	0.358 *0.049*	0.792	0.814
Price	0.365 *0.025*	0.384 *0.066*	0.817	0.826
Demand Shock	0.619 *0.013*	0.843 *0.021*	0.909	0.966

Variable	Plant Age Dummies			
	Exit	Entry	Young	Medium
Unweighted Regressions				
Traditional TFP	-0.0211	0.0044	0.0074	0.0061
	0.0042	*0.0044*	*0.0048*	*0.0048*
Revenue TFP	-0.0220	0.0133	0.0075	0.0028
	0.0044	*0.0047*	*0.0051*	*0.0053*
Physical TFP	-0.0186	0.0128	0.0046	-0.0039
	0.0050	*0.0053*	*0.0058*	*0.0062*
Price	-0.0034	0.0005	0.0029	0.0067
	0.0031	*0.0034*	*0.0038*	*0.0042*
Demand Shock	-0.3466	-0.5557	-0.3985	-0.3183
	0.0227	*0.0264*	*0.0263*	*0.0267*

Determinants of Market Selection

Specification:	[1]	[2]	[3]	[4]	[5]	[6]	[7]
Traditional TFP	-0.073						
	0.015						
Revenue TFP		-0.063					
		0.014					
Physical TFP			-0.040			-0.062	-0.034
			0.012			*0.014*	*0.012*
Prices				-0.021		-0.069	
				0.018		*0.021*	
Demand Shock					-0.047		-0.047
					0.003		*0.003*

Note: Much greater dispersion in demand shocks than physical TFP

Establishment-level Productivity Empirical Patterns

- Dispersion (large), persistence (high) evolution (consistent with learning and selection)
- Selection
  - Lower productivity plants exit
  - Other determinants of productivity matter
  - Open questions: Impact of distortions on selection?
    - Models like Melitz (2003) and Restuccia and Rogerson (2007) imply reduced distortions will improve selection
    - Eslava et. al. (2009) find evidence that trade liberalization improves market selection
- These patterns both support basic models and can be used to test and estimate models
- One other approach has to been to explore the covariance between size and productivity within industries.
  - Basic prediction of virtually all models is positive correlation between size and profitability/productivity

Within Industry Dynamic Decomposition Applied to FHS (2008) data

		Components of Decomposition (GR)				
		Within	Between	Entry	Exit	Net Entry
Traditional	2.30	1.40	0.18	0.44	0.27	0.72
Revenue	5.13	4.03	0.16	0.55	0.39	0.94
Physical	5.13	3.82	-0.05	1.04	0.32	1.36

Extra Slides

Growth Identities: Establishment

$$g_{it} = (E_{it} - E_{it-1}) / X_{it}$$

where

$$X_{it} = .5 * (E_{it} + E_{it-1})$$

Then

$$JC_{it} = \max(g_{it}, 0)$$

$$JD_{it} = \max(-g_{it}, 0)$$

From Entry/Exit

$$JC_{it} = \max(g_{it}, 0) * I\{g_{it} = 2\}$$

$$JD_{it} = \max(-g_{it}, 0) * I\{-g_{it} = 2\}$$

Growth Identities: Aggregate Measures (any level)

$$JC_t = \sum_i (X_{it} / X_t) \max\{g_{it}, 0\} \qquad JD_t = \sum_i (X_{it} / X_t) \max\{-g_{it}, 0\}$$

$$JC\_Entry_t = \sum_i (X_{it} / X_t) I\{g_{it} = 2\} \max(g_{it}, 0)$$

$$JD\_Exit_t = \sum_i (X_{it} / X_t) I\{g_{it} = -2\} \max(-g_{it}, 0)$$

$$g_t = JC_t - JD_t$$

$$JC_t = JC\_Cont_t + JC\_Entry_t$$

$$JD_t = JD\_Cont_t + JD\_Exit_t$$