Firm Dynamics and Aggregate Fluctuations: (Some) Open Questions

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Core Question

- What is the link between differences in productivity across countries and differences in productivity across firms within countries?
  - Both exhibit substantial dispersion and persistence.
  - Theory suggests these are potentially linked.
  - Empirical evidence offers support.
  - But the details matter…

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

- Syverson (2004) documents interquartile range of plant-level productivity in U.S. is around 0.30 within narrowly defined industries.
- Hsieh and Klenow (2009) document that dispersion in productivity is higher in China and India than in the U.S.
- World Development Report (2013) documents tendency for higher dispersion in productivity in emerging economies relative to U.S.
- At first glance, suggests substantial improvements in AGGREGATE productivity could be achieved by reallocation of resources away from less productive to more productive businesses within industries.
  - Apparently more possible gains in emerging economies.
- But key open questions:
  - What are we measuring?
  - What underlies this dispersion?

TFPR vs. TFPQ

- Conceptually, TFP a proxy for technical efficiency
- But in firm/plant-level data important to distinguish between TFPR and TFPQ
- We don't typically have direct measures of TFPQ but rather TFPR at firm/plant level because we don't observe prices at the firm/plant level.

Canonical, Frictionless Model

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

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

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

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

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

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

$$TFPQ = A$$

Cobb-Douglas Technology, CRS
Isoelastic Demand, No Frictions, No Distortions,
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

Evidence on TFPQ vs. TFPR for U.S.

- 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 vs. Distortions?

- Costs of Entry (and exit)
  - Including costs of entering new markets
- Learning (initial conditions and after changing products/processes)
  - 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

Important for Trade/Productivity Literature

- Core findings from firm-level trade literature:
  - Trade is “rare” – most firms don’t engage in trade.
  - More “productive” and larger firms engage in trade.
  - Amongst trading firms, trade is concentrated – most trade accounted for by the largest firms.
  - Causality between trade and productivity?
    - While still an open question, evidence is all about TFPR and NOT TFPQ!

2. What is the relative importance of demand vs. supply factors in dispersion across firms (including in TFPR)?

- Canonical models focus on firm-level productivity as primary source of firm heterogeneity
  - Many interpret TFPR variation as TFPQ variation
    - Firm heterogeneity and trade literature especially even if demand structure is considered
- Evidence suggests demand side factors are important and are endogenous over firm life-cycle

Supply-side vs. Demand-side

- Regression of fundamentals and plant age dummies (and industry-year effects).

Variable	Entrant	Young	Medium	Exit
TFPQ	0.013	0.004	-0.004	-0.018
	(0.005)	(0.006)	(0.006)	(0.005)
Demand	-0.550	-0.397	-0.316	-0.339
	(0.022)	(0.024)	(0.026)	(0.021)

Demand Side

- Dynamic demand-side forces take time to play out.
  - Growth of a customer base
  - Building a reputation
  - Uncertainty about demand may create option value of waiting to expand
- Customer Learning
  - Details of product attributes
  - Quality and quantity of bundled services
  - Consistency of operations
  - Longevity

Dynamic Model

Production Function: $q_t = A_t x_t$

Demand Curve: $q_t = \theta_t Age_t^{\phi} Z_t^{\gamma} p_t^{-\eta}$

Evolution: $Z_t = (1-\delta) Z_{t-1} + (1-\delta) R_{t-1}$

Initialization: $Z_{0e} = (K_{0e})^{\lambda_1} \left(\dfrac{K_{0s(e)} + K_{0e}}{K_{0e}} \right)^{\lambda_2}$

Profits: $\pi_t = p_t A_t x_t - c_t x_t - f$

Estimating Model

Demand Equation:

$$\ln q_{t+1} = \rho \ln q_t + \phi \ln Age_{t+1} - \rho\phi \ln Age_t$$
$$+ \gamma \ln Z_{t+1} - \rho\gamma \ln Z_t - \eta \ln p_{t+1} + \rho\eta \ln p_t + \upsilon_{t+1}$$

Euler Equation:

$$E[\varepsilon_{t+1}] = \frac{C_t}{R_t} - \left(1 - \frac{1}{\eta}\right) - \frac{\beta(1-\delta)\gamma}{\eta}\frac{R_{t+1}}{Z_{t+1}} - \beta(1-\delta)\left(\frac{C_{t+1}}{R_{t+1}} - \left(1 - \frac{1}{\eta}\right)\right) = 0$$

Learning with Depreciation Model

Parameter	Coefficient	S E
γ	0.795	(0.014)
Young dummy	-0.066	(0.031)
Medium dummy	-0.025	(0.026)
ρ	0.366	(0.085)
λ_1	0.651	(0.051)
λ_2	0.548	(0.063)
η	-1.808	(0.082)
Competitors Price	0.338	(0.073)
δ	0.893	(0.026)
Inverse Mills Ratio, Demand	-0.022	(0.009)
Inverse Mills Ratio, EE	0.026	(0.005)

Decomposing Demand Shocks

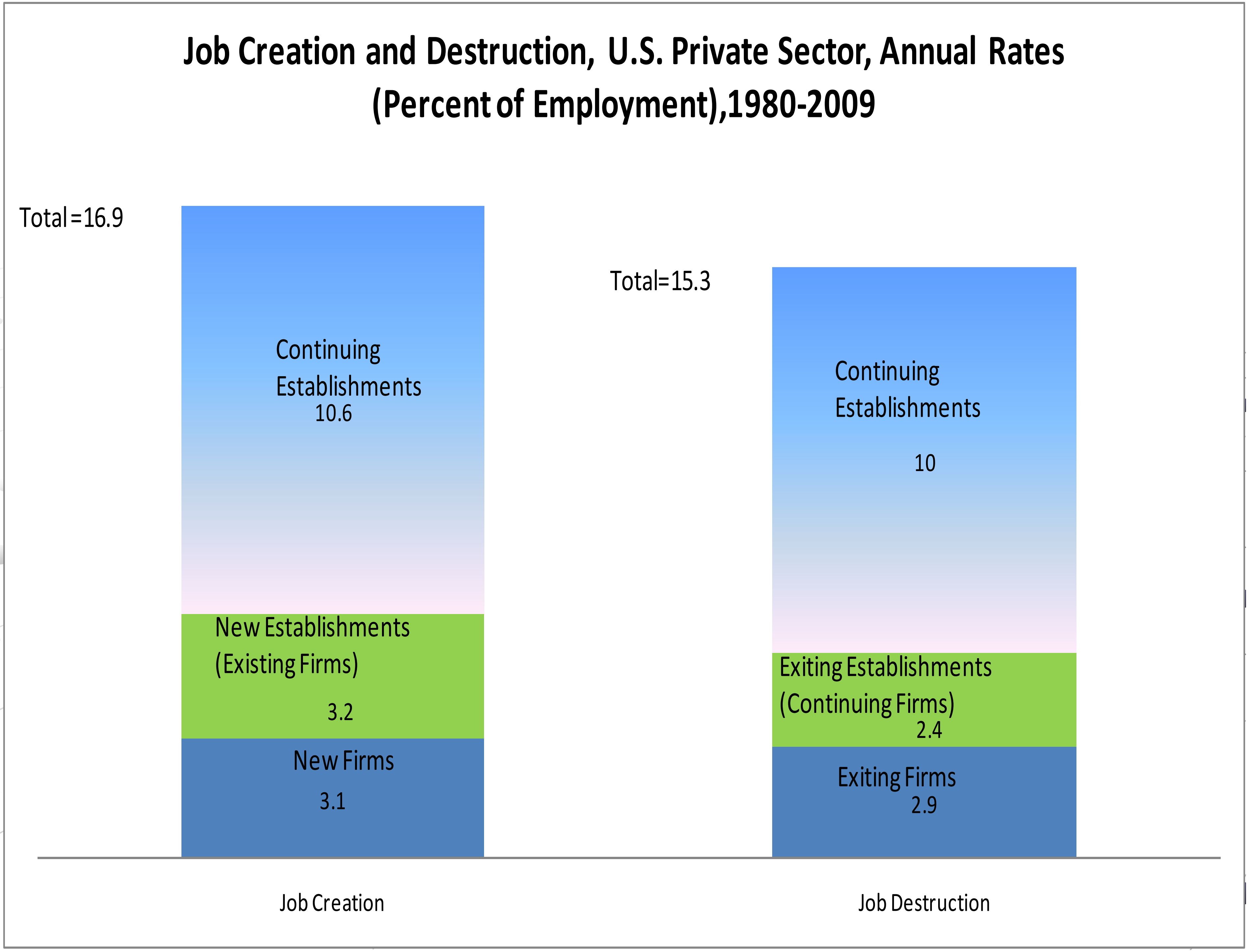
Variable	Young	Medium	Old
Demand Shock	-0.575	-0.287	Excl.
	(0.020)	(0.029)	
Active Accumulation	-0.617	-0.271	Excl.
	(0.017)	(0.025)	
Passive Accumulation	-0.066	-0.025	Excl.
	(0.031)	(0.026)	

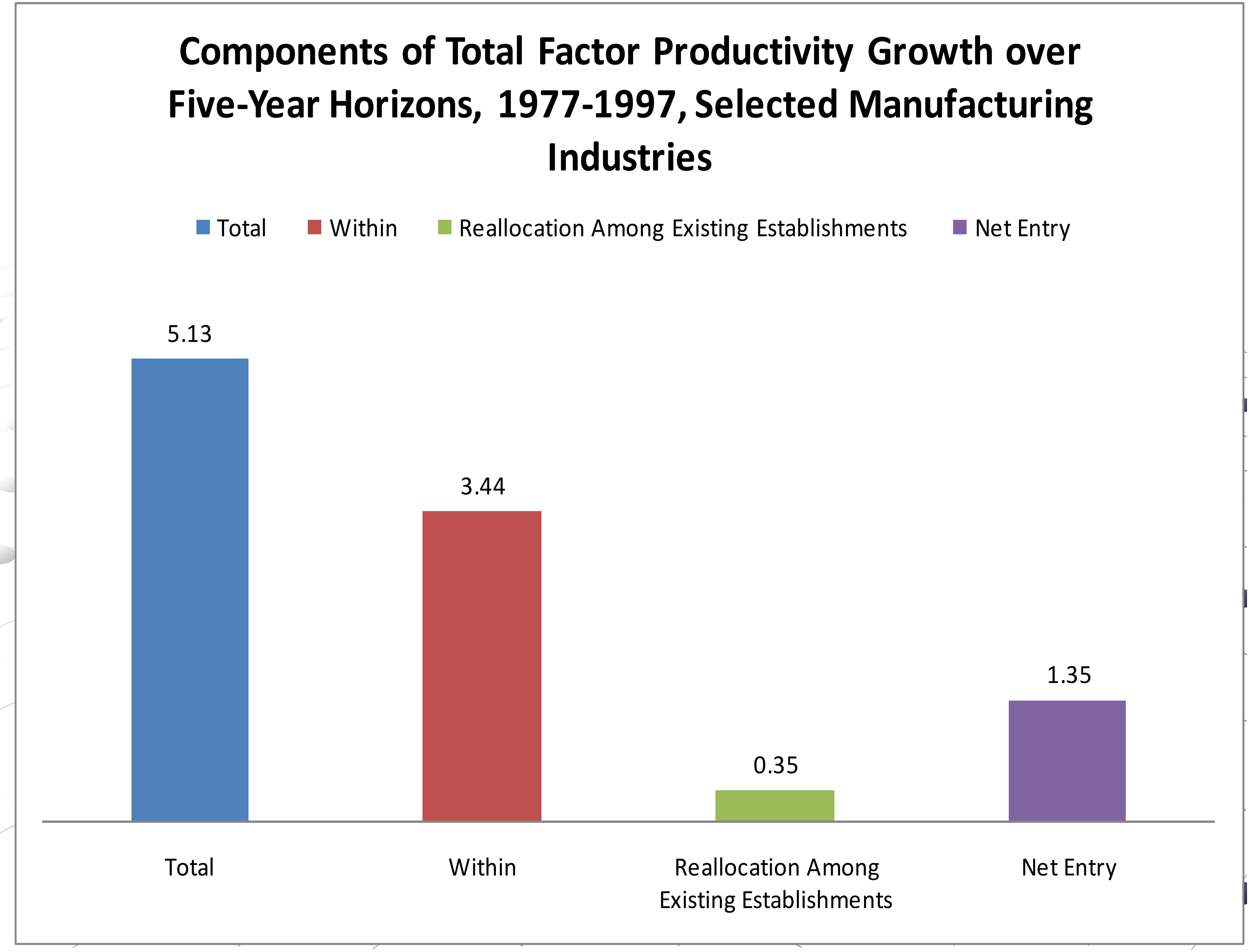
Quick summary and questions

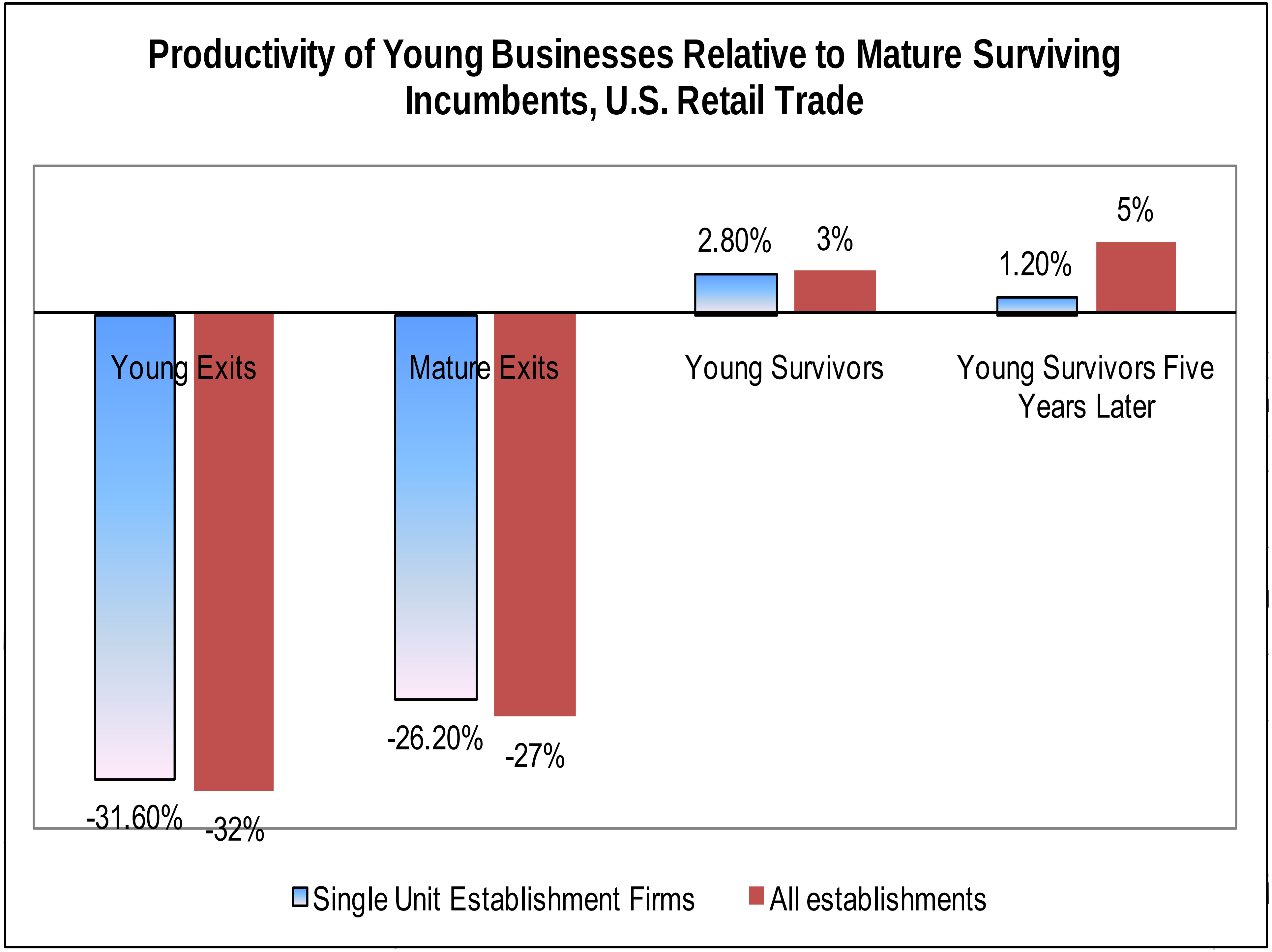
- It takes a long time for entering plants to grow to the size of incumbents.
- The demand side plays a larger part in the persistence of the size gap than does the supply side.
- Evidence suggests young firms actively invest in at active demand accumulation by cutting prices when young.
- Frictions relevant for new firms and new activity in a new location (trade activity).

3. Do we need a high pace of reallocation including entry/exit to achieve allocative efficiency?

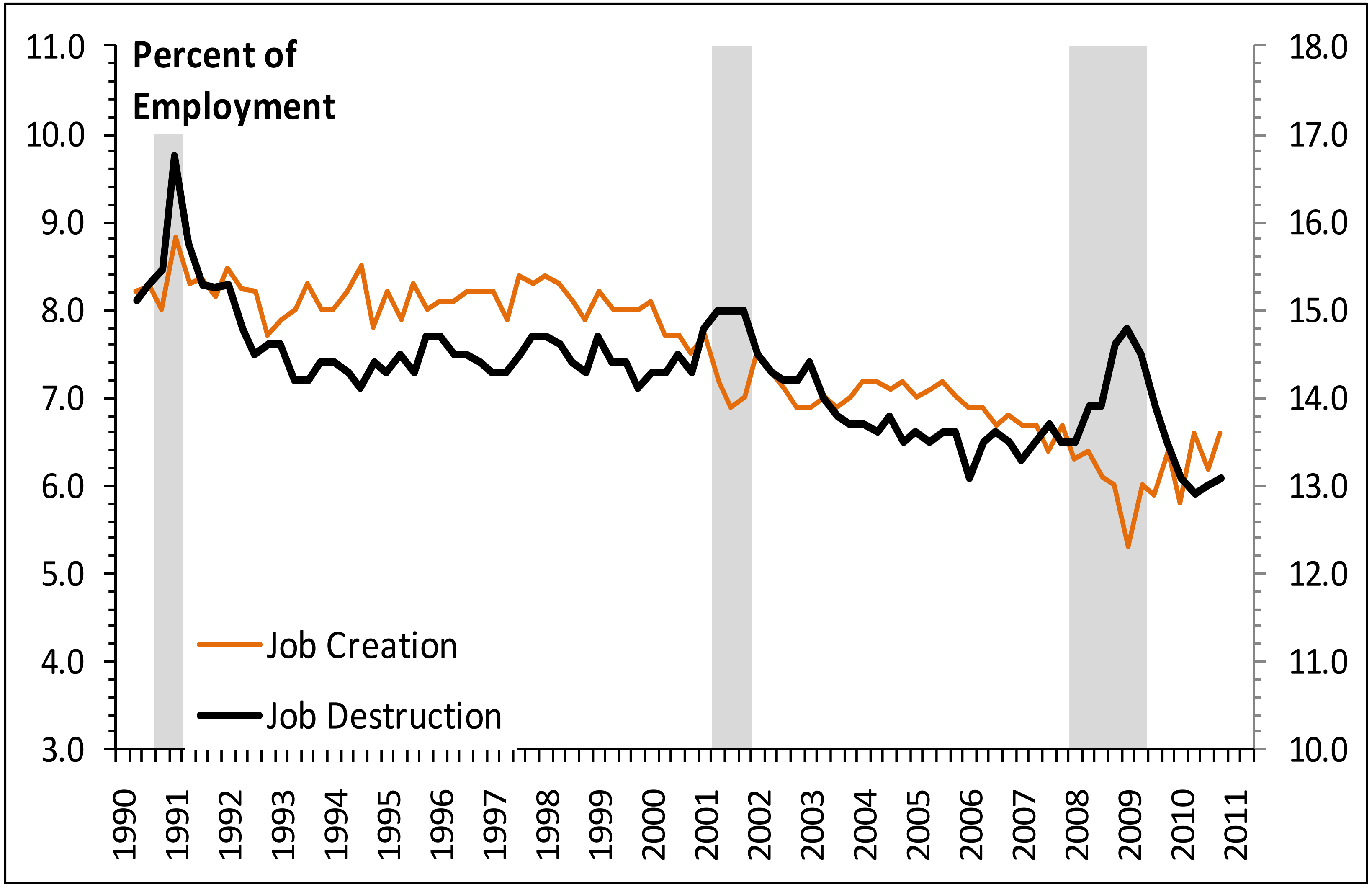
- U.S. in particular has a high pace of output and input reallocation
  - Very costly
  - Possible distortions – cyclically and secularly
- In “Long Run”, appears to payoff – reallocation and productivity closely connected
  - Caution: Might be demand side factors driving reallocation as well – okay but perhaps different frictions are important.


Job Creation and Destruction, U.S. Private Sector, Annual Rates
(Percent of Employment),1980-2009
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


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
2.80%
3%
5%
1.20%
Young Exits
Mature Exits
Young Survivors
Young Survivors Five Years Later
-31.60%
-32%
-26.20%
-27%
Single Unit Establishment Firms
All establishments

Declining Pace of Creation and Destruction in BED



Source: BLS BED DATA, Davis, Faberman and Haltiwanger (2011)

4. What firm level moments should we use to identify distortions and quantify the extent of misallocation?

Hsieh and Klenow (2009) approach

- All TFPR dispersion is due to distortions.
- Countries "distortion" index can be estimated directly from TFPR dispersion
  - Higher TFPR dispersion countries are more distorted.
  - Hsieh and Klenow find that TFPR dispersion is much higher in China and India than U.S.
    - They estimate the degree of distortions in China an and India and calculate the gains in aggregate productivity that will be realized if China/India coverge to U.S. TFPR dispersion.
- Is this a reasonable identification approach?

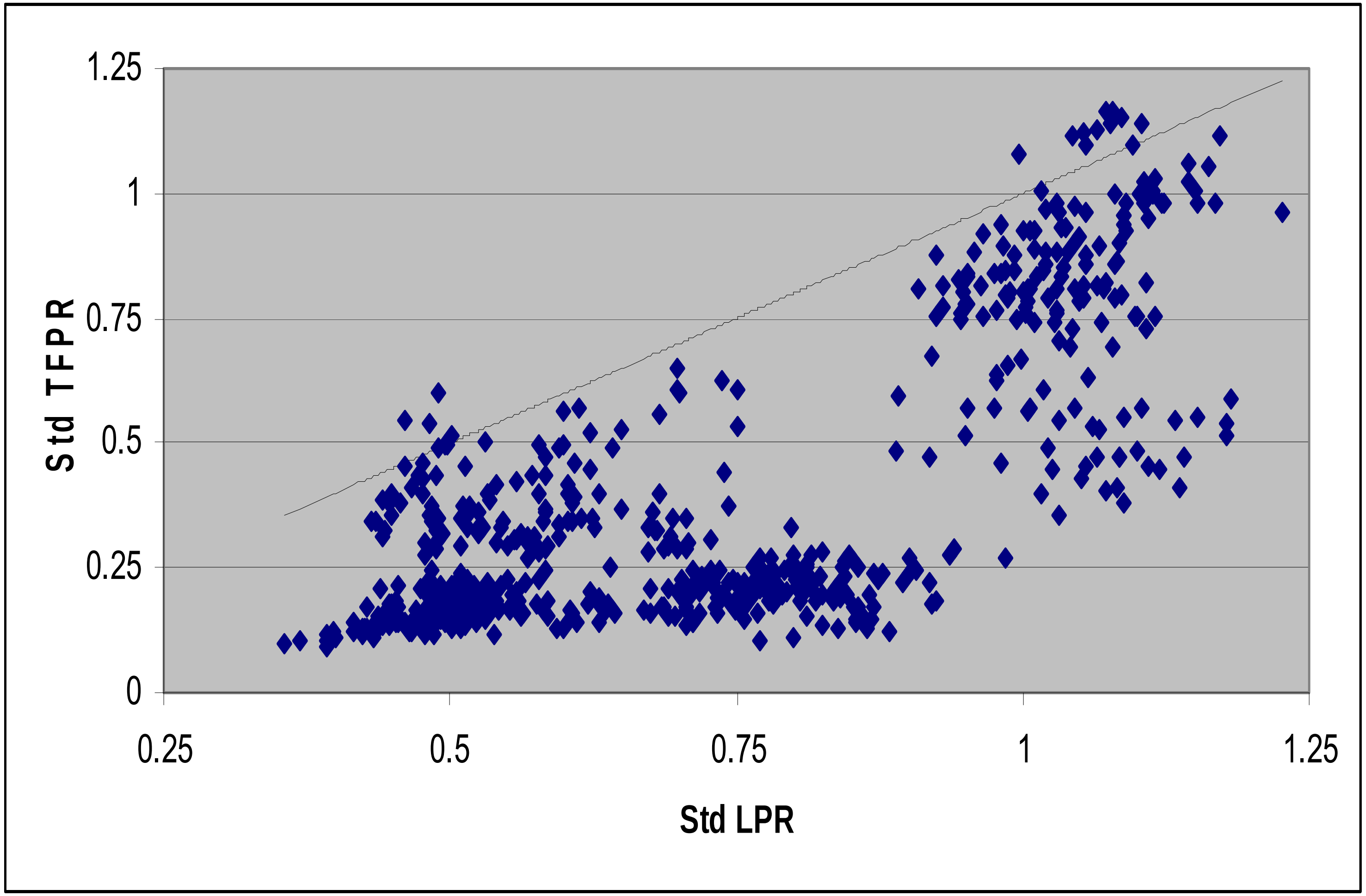
Table 1: Within Industry Productivity Dispersion and OP Covariance Term

(weighted averages of industry-level data, U.S. Industry Weights)

	Revenue Labor Productivity Std Dev.	Revenue TFP Std Dev.	OP covariance term
United States	0.58	0.38	0.51
United Kingdom	0.57	0.41	0.16
Germany	0.72	NA	0.28
France	0.53	0.22	0.24
Netherlands	0.56	0.15	0.30
Hungary	1.03	0.91	0.18
Romania	1.05	0.56	-0.03
Slovenia	0.80	0.22	0.05

Notes: Averages over 1992-2001 data. Industry-level firm based TFP measures not available for Germany.

More than 5200 country/industry/year observations of some of the key moments -- virtually all show STD(LPR)>STD(TFPR)



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A Model of "Mis"-Allocation (Based on Rogerson and Restuccia (2008) (and similar to Hsieh and Klenow (2009))

Consumers supply labor inelastically and maximize utility:

$$\sum_{t=0}^{\infty} \beta^t U(C_t)$$

Firms maximize profits where:

$$\pi_{it} = (1-\tau_i-\kappa_{it})P_t\theta_i \bar{Y}_t^{1-\rho} [A_i\varepsilon_{it}(n_{it}-f)^{\gamma} k_{it}^{\alpha}]^{\rho} - w_t n_{it} - Rk_{it}$$

$$Y_{it} = A_i\varepsilon_{it}(n_{it}-f)^{\gamma-\alpha} k_{it}^{\alpha}, \gamma < 1$$

$$Y_t = N_t^{(\rho-1)/\rho}(\sum_i \theta_i Y_{it}^{\rho})^{1/\rho} \qquad P_{it} = P_t\theta_i(\bar{Y}_t / Y_{it})^{1-\rho}$$

Our innovations: Overhead labor, quasi-fixed capital and transitory shocks
Yields dispersion in TFPR and LPR even in absence of distortions

Entry/Selection

$$W^e = \int_{A.\tau} \max(0, W(A,\tau)dG(A,\tau)) - c_e$$

$$G(A,\tau)$$ Ex Ante Joint Distribution

$$W(A_i,\tau_i) = E\,[\pi(A_i,\tau_i,\kappa_{it},\varepsilon_{it})]/(1-\chi)$$

$$\chi = (1-\lambda)/(1+r)$$

Exogenous probability of exiting in each period given by λ

Aggregate Relationships and Steady State Equilibrium

$$C_t + E_t c_e + \delta K_t = Y_t$$

Resources expended on entry/exit impact consumption and welfare

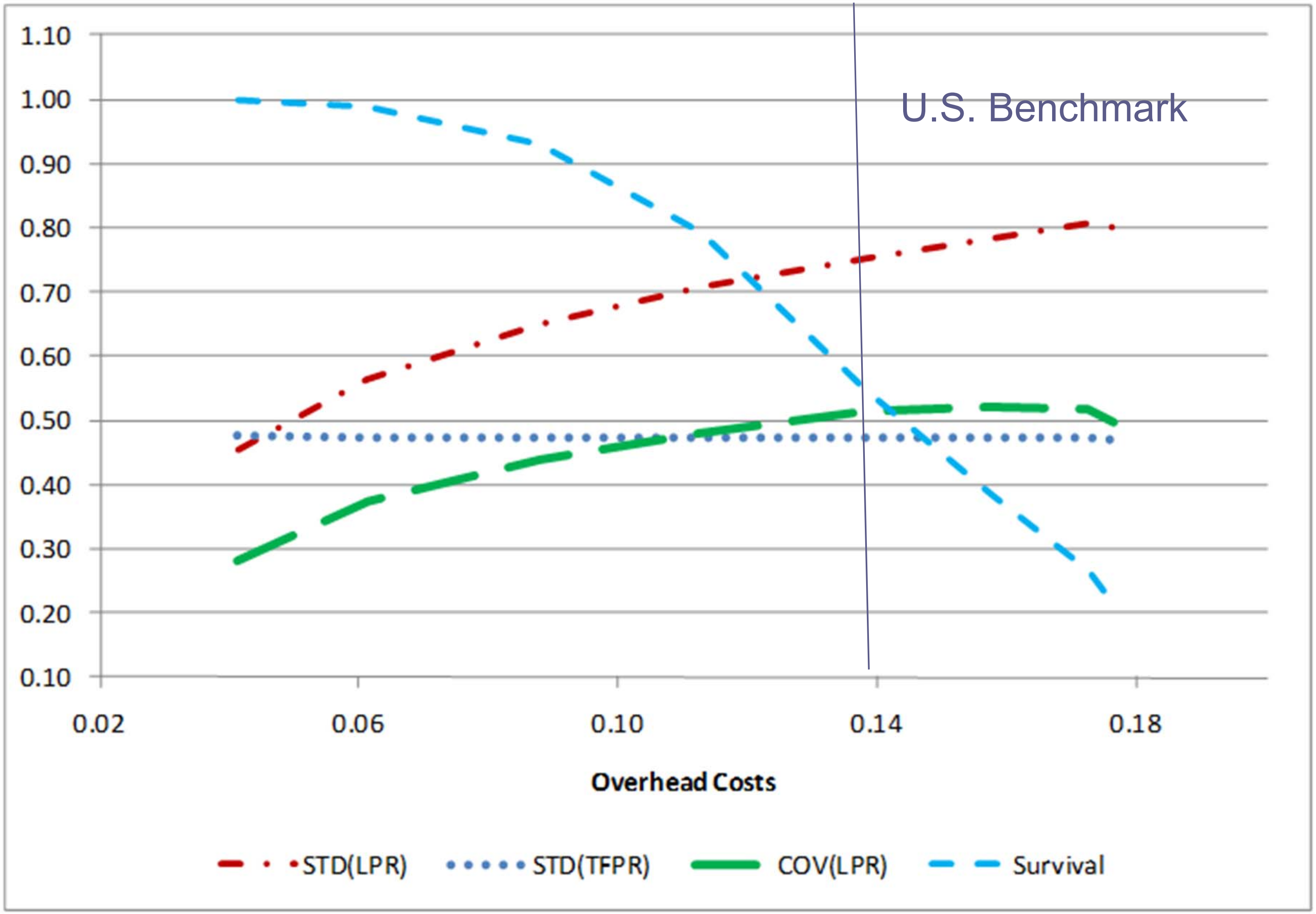
$$W^e = 0, N^d = N^s$$

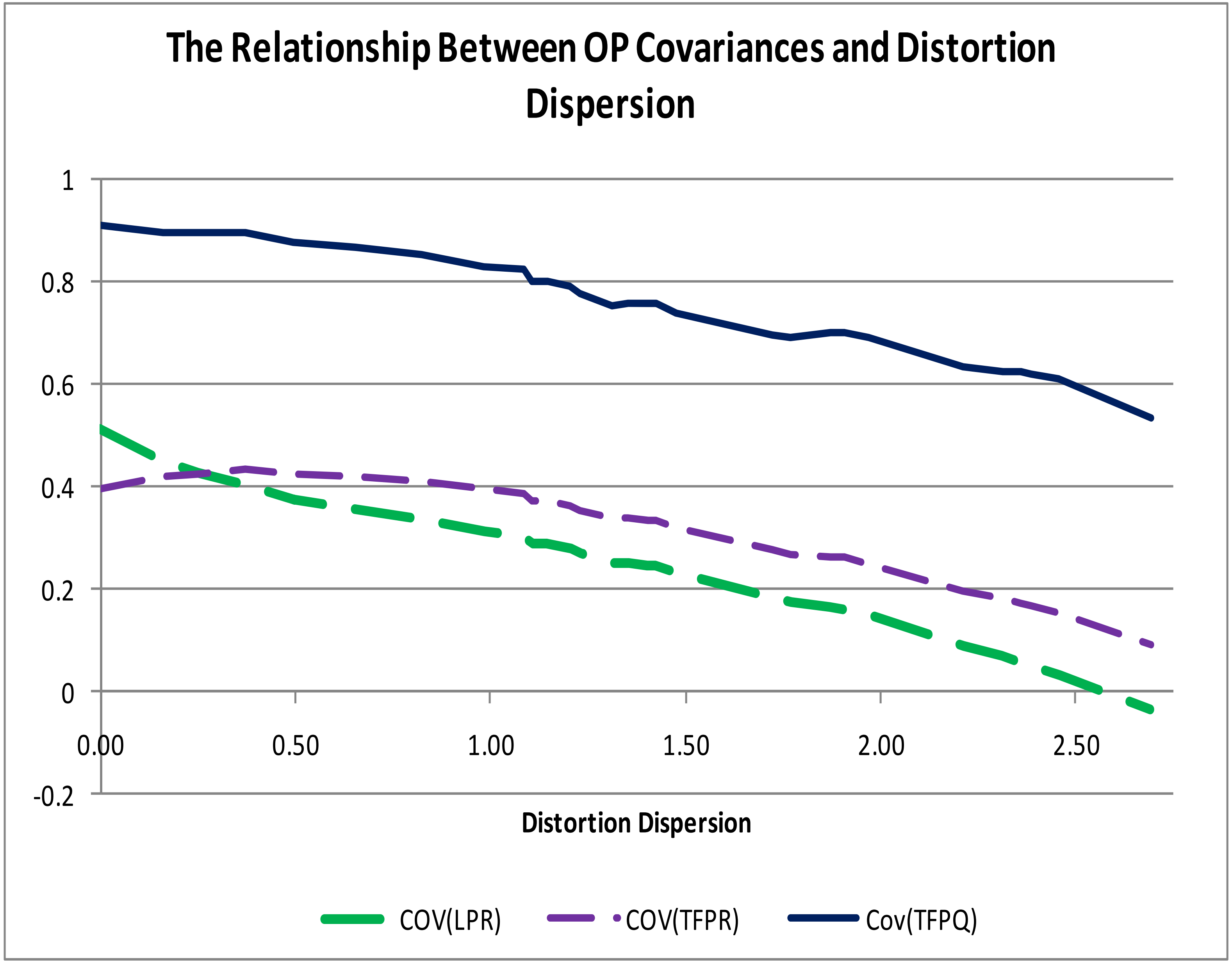
Free entry condition and equilibrium in labor market

Key Relationships…

Consider briefly simpler model with no transitory shocks:

Non distorted economy responsiveness to overhead labor




The Relationship Between OP Covariances and Distortion Dispersion
1
0.8
0.6
0.4
0.2
0
-0.2
0.00
0.50
1.00
1.50
2.00
2.50
Distortion Dispersion
COV(LPR)
COV(TFPR)
Cov(TFPQ)

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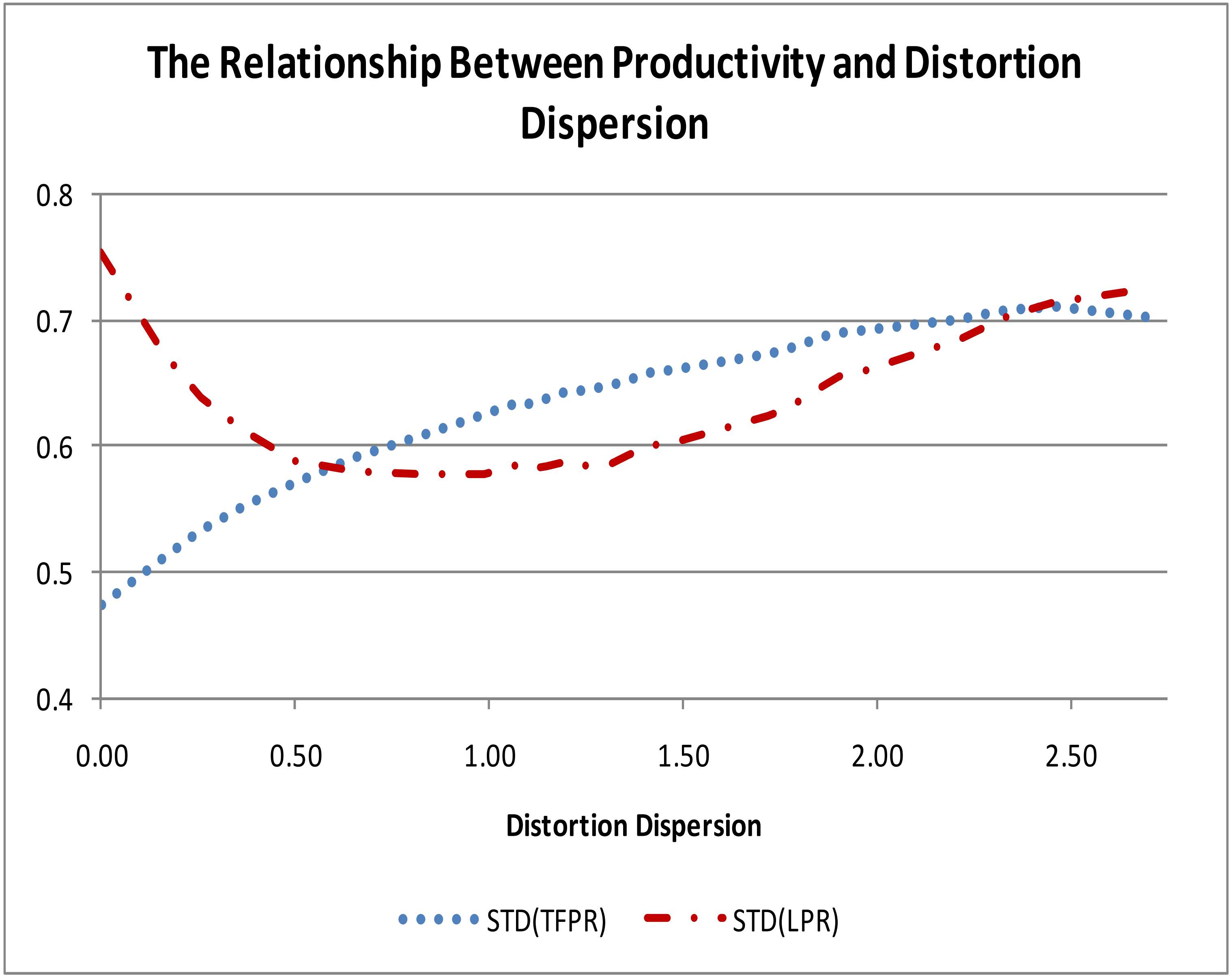
The Relationship Between Productivity and Distortion Dispersion
0.8
0.7
0.6
0.5
0.4
0.00
0.50
1.00
1.50
2.00
2.50
Distortion Dispersion
STD(TFPR)
STD(LPR)

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Using distortions to match OP-gap

Country	COV_LPR (Data)	COV_LPR (Model)	STD_LPR (Data)	STD_LPR (Model)	STD_TFPR (Data)	STD_TFPR (Model)	Consumption Index (Model)
United States	0.51	0.51	0.58	0.75	0.38	0.47	1.00
United Kingdom	0.16	0.16	0.57	0.65	0.41	0.69	0.93
Germany	0.28	0.28	0.72	0.59	na	0.64	0.97
France	0.24	0.24	0.53	0.60	0.22	0.66	0.96
Netherlands	0.30	0.30	0.56	0.59	0.15	0.63	0.97
Hungary	0.18	0.18	1.03	0.63	0.91	0.68	0.94
Romania	-0.03	-0.03	1.05	0.72	0.56	0.70	0.88
Slovenia	0.05	0.05	0.80	0.71	0.22	0.71	0.90

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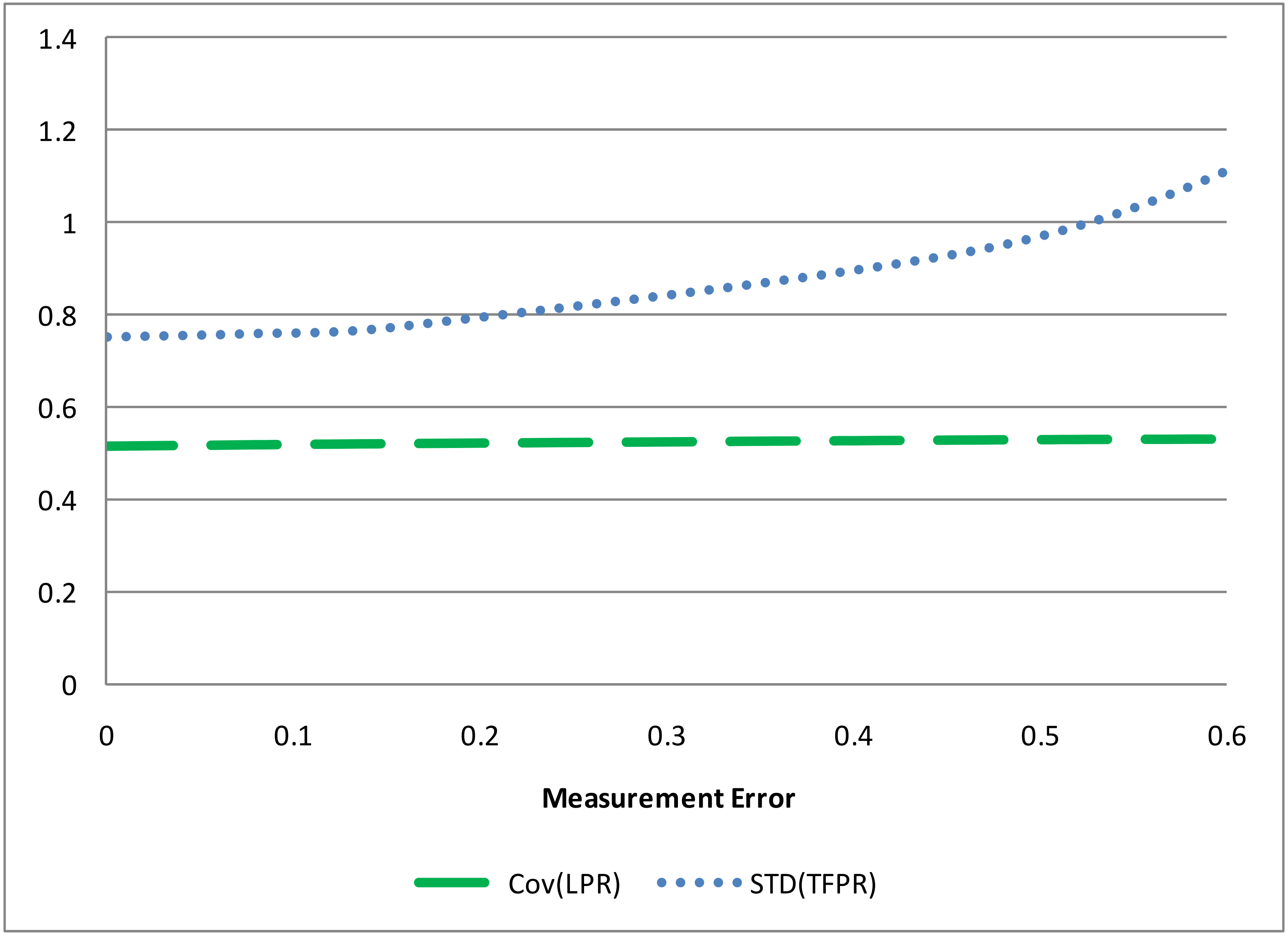
Robustness: Multiplicative Measurement Error in Output (additive in logs)



Concluding Remarks

- Aggregate and Micro Productivity Dispersion inherently linked via allocative efficiency.
- But many conceptual and measurement challenges:
  - Much of the firm-level evidence is about TFPR and not TFPQ.
    - Some parts of the literature have not fully taken this into account.
  - The recent misallocation literature builds on the distinction between TFPR and TFPQ.
    - But identification and measurement challenges **remain.**