Comments on BLS-Census Micro-Productivity Project

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Calculating Multi-Factor Productivity Using Micro Data

- One of the most important variables to help understand firm and industry performance
- Does micro data give a similar picture of industry/aggregate productivity movements
- A robust, consistently-defined measure available to RDC users would be widely used
- Stepping stone to moving beyond manufacturing to large sectors of the economy
- Excellent project that uses the expertise of BLS and Census

Growth Accounting and Index Numbers

- Developed for aggregate time-series comparisons and Tornqvist index is the basis for BLS program

$$\Delta MFP_t = (\ln Q_t - \ln Q_{t-1}) - \sum_i \frac{1}{2}(S_{it} + S_{it-1})(\ln X_{it} - \ln X_{it-1})$$

In practice it captures numerous factors: shifts in production function, movements across short-run equilibria, returns to scale. Allows flexible technology and does not impose Hick's neutral technical change

- Issues when moving to micro data:

$$MFP_{ft} = \ln Q_{ft} - \sum_i S_{ift} \ln X_{ift}$$

  - What is the reference point? Without reference point it depends on units of measure
  - How are factor shares treated? If constant for all firms it imposes Cobb-Douglas form, Hicks neutral technology differences
  - How to deal with entry and exit?

Production Function Estimation (Olley-Pakes)

Production Function:

$$\ln Q_{ft} = \beta_0 + \sum_i \beta_i \ln X_{ift} + \omega_{ft} + \varepsilon_{ft}$$

Two sources of noise: productivity ω_{ft} is observed by the firm prior to variable input choice, random shocks to ε_{ft} is not. Variable input levels are endogenous and OLS estimates of β_i are biased upward

Productivity Evolution:

$$\omega_{ft} = g(\omega_{ft-1}) + \nu_{ft}$$

Estimation relies on the presence of an additional variable that is correlated with ω that can be used to control for ω in production function (investment, materials, labor)

Productivity is (generally) constructed as:

$$\hat{w}_{ft} = \ln Q_{ft} - \hat{\beta}_0 - \sum_i \hat{\beta}_i \ln X_{ift} +$$

Critique of Production Estimation

- Strengths
  - Sensible model of firm choice, observe a serially correlated ω
  - Gives estimates of productivity for each observation - firm/time
  - Can separate productivity from returns to scale
- Weaknesses
  - Large degree of arbitrariness about control variable.
  - Decision depends on (unverifiable) assumptions about timing of variable input choice
  - Productivity estimates depend on this assumption
  - Cobb-Douglas function implies constant output elasticities/factor shares across observations
  - New year of data - reestimate the production function?
  - Assumes Hick's neutral technology differences across observations

Hick's Neutral Technology Assumption

Problematic assumption in cross-section firm data.
How to explain the large variation in K/L and M/L ratios for firms of different sizes?
Factor price differences are too small - need enormous elasticities of substitution
Labor saving technology bias is a possible explanation.

Production Models with Biased Technology Differences - utilize information on the variation in input cost shares to estimate non-neutral or factor-augmenting technologies.
Gandhi, Navarro, and Rivers (2009), Doreszelski and Jaumandreu (2014), Zhang (2014).

This further complicates production function estimation.

Cross-Sectional Variation: Input Levels vs Shares

Across firm variation in input shares is substantial in micro data

	P10	P50	P90	(P90-P10)/P50
log L	1.10	2.49	4.25	1.27
Sl	.089	.198	.374	1.44
log M	7.04	8.84	11.23	0.47
Sm	.367	.564	.751	0.68
log K	8.03	9.26	11.42	0.36
Sk	.080	.192	.344	1.37
log Q	7.90	9.57	11.85	0.41

Taiwan electronics industry, 8003 firms in 1991

Cross sectional dispersion in each input's revenue share $>$ dispersion in log input level

Multilateral Index Numbers

$$MFP_{ft} = (\ln Q_{ft} - \ln Q_t^R) - \sum_i \frac{1}{2}(S_{ift} + S_{it}^R)(\ln X_{ift} - \ln X_{it}^R)$$

$\ln Q_t^R, \ln X_{it}^R, S_{it}^R$ correspond to a reference point (hypothetical firm) with mean log input/output and mean factor shares.

- Recognizes firm variation in output, inputs, and revenue shares
- Does not assume Hick's neutral differences across firms
- Every firm is compared to reference point, transitive comparisons among firms, unit free
- The firm shares are smoothed by averaging with S_{it}^R
- Reference points can be chain-linked over time, allows time-series comparisons of reference firm
- Additional years do not disturb the historical series
- Can use firm's with one year of data
- Problem with unreasonable shares - trimming necessary

Other Issues: Imputation and Reporting

- Constructing the reference point in each year
  - Use firms without imputed data, together with sampling weights to construct input, output, share means
  - Compare changes over time with aggregate BLS stats
- Data avalible in RDCs
  - Can construct MFP_{ft} for each observation - flags indicating what data is imputed
- Reporting for public use
  - Picture of the Cross-section Distribution of MFP_{ft} - Percentiles, Robust Measures of Dispersion
  - For industries -revenue share-weighted sum: $WMFP_t = \sum_f wr_{ft} MFP_{ft}$, contribution of separate inputs to output

Conclusions and Recommendations

not the opinion of the Census Bureau, BLS or.......

Very valuable project with many potential uses.
Avoid production function estimation - not appropriate for robust statistical products
Pursue multilateral index numbers - matches well with BLS program
Focus on reconciling reference point in micro data with industry aggregates.
Interpretation of MFP_{ft} as a measure of resource allocation, not shift in production function, is fine

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