World Productivity: 1996-2014[1]

Mehrdad Esfahani[a] John G. Fernald[b] Bart Hobijn[a]

[a] ASU W. P. CAREY SCHOOL of BUSINESS [b] INSEAD and Federal Reserve Bank of San Francisco

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[1] The views expressed in this paper are those of the authors and do not necessarily reflect the position of the Federal Reserve Bank of San Francisco or the Federal Reserve System.

Global growth accounting: Our three contributions

Introduce normative growth-accounting decomposition

- Market allocation with distortions in product, capital, and labor markets

Baqaee & Farhi (2017), Basu & Fernald (1997), Hulten (1978)

- Normative reinterpretation of conventional growth accounting terms

Domar (1962), Jorgenson *et al.* (1987)

Decompose both world ALP and TFP growth

- Use World Input-Output Tables data — Timmer (2012),Timmer *et al.* (2015)
- Construct country-industry level PPP data to quantify international cost advantages

Timmer *et al.* (2007)

Provide a new high-level picture of global productivity growth

Global growth accounting: 30,000 ft perspective

Provide a new high-level picture of global productivity growth

- **Fluctuations** World ALP and TFP growth fluctuates a lot
- **Misallocation** Misallocation of labor net drag and main source of global productivity growth fluctuations

  Global analysis of misallocation of resources: Hsieh & Klenow (2009),Restuccia & Rogerson (2008),Klein & Ventura (2009)

- **Country-industry level productivity growth** Country-industry level contributions relatively constant

  Acceleration in China and India offsets productivity slowdown in industrialized economies Byrne *et al.* (2016), ECB (2017), OECD (2017)

Normative growth-accounting framework:

Derive growth-accounting decomposition in economy with distorted market equilibrium.

Baqaee & Farhi (2017), Basu & Fernald (1997)

Relate terms in decomposition to undistorted case and to different market distortions.

Hulten (1978), Domar (1962)

Our normative growth-accounting result fills a void

	Efficient	Distorted
Planner	**Efficient Production Possibility Frontier** Hulten (1978)	**Distorted Production Possibility Frontier** Define distorted planner problem. Take time-derivative of planner's objective.
Market	**Conventional growth accounting** Jorgenson *et al.* (1987), Domar (1962)	**Growth accounting with distortions** Baqaee & Farhi (2017), Basu & Fernald (1997)

Supply side of distorted decentralized economy

Producers choose the factor inputs, $\left\{K_i, L_i, \{M_{i,j}\}_{j=1}^{n}\right\}$, to minimize their cost of production

$$\left(1+\tau_i^K\right) R_i K_i + \left(1+\tau_i^L\right) W_i L_i + \sum_j \left(1+\tau_i^j\right) P_j M_{i,j},$$

subject to the constraint that they produce a given level of output

$$Y_i = Z_i F_i \left(K_i, L_i, \{M_{i,j}\}_{j=1}^{n}\right).$$

Distortionary taxes: τ_i^K, τ_i^L, and τ_i^j. Charge net markup μ_i over unit production cost.

Baqaee & Farhi (2017)

Demand side of distorted decentralized economy

Final demand and sector-specific factor supplies, $\{K_i, L_i, D_i\}_{i=1}^n$, are chosen to maximize

$$D = \mathcal{G}\left(\{D_i\}_{i=1}^n\right)$$

subject to the budget constraint

$$\sum_i \left(1 + \tau_i^D\right) P_i D_i = \sum_i R_i K_i + \sum_i W_i L_i + \sum_i \frac{\mu_i}{1+\mu_i} P_i Y_i + \tau,$$

and the factor-supply constraints

$$\begin{aligned} K &= \mathcal{K}\left(\{K_i\}_{i=1}^n\right) \\ L &= \mathcal{L}\left(\{L_i\}_{i=1}^n\right). \end{aligned}$$

Lump-sum transfers equal

$$\tau = \sum_i \tau_i^K R_i K_i + \sum_i \tau_i^L W_i L_i + \sum_i \sum_j \tau_i^j M_{i,j} + \sum_i \tau_i^D P_i D_i.$$

Market equilibrium with distorted marginal conditions

Market equilibrium allocation determined by distorted optimality conditions

$$\left(1+\tau_i^K\right)\frac{R_i}{P} = \frac{1}{(1+\mu_i)}\frac{P_i}{P}Z_iF_i^K, \text{ where } F_i^K = \frac{\partial}{\partial K_i}F_i\left(K_i, L_i, \{M_{i,j}\}_{j=1}^n\right),$$

$$\left(1+\tau_i^L\right)\frac{W_i}{P} = \frac{1}{(1+\mu_i)}\frac{P_i}{P}Z_iF_i^L, \text{ where } F_i^L = \frac{\partial}{\partial L_i}F_i\left(K_i, L_i, \{M_{i,j}\}_{j=1}^n\right),$$

$$\left(1+\tau_i^j\right)\frac{P_j}{P} = \frac{1}{(1+\mu_i)}\frac{P_i}{P}Z_iF_i^j, \text{ where } F_i^j = \frac{\partial}{\partial M_{i,j}}F_i\left(K_i, L_i, \{M_{i,j}\}_{j=1}^n\right),$$

$$U_i = \left(1+\tau_i^D\right)\frac{P_i}{P}, \text{ where } \mathcal{G}_i = \frac{\partial}{\partial D_i}\mathcal{G}\left(\{D_i\}_{i=1}^n\right),$$

$$\frac{R}{P}\mathcal{K}_i = \frac{R_i}{P}, \text{ where } \mathcal{K}_i = \frac{\partial}{\partial K_i}\mathcal{K}\left(\{K_i\}_{i=1}^n\right),$$

$$\frac{W}{P}\mathcal{L}_i = \frac{W_i}{P}, \text{ where } \mathcal{L}_i = \frac{\partial}{\partial L_i}\mathcal{L}\left(\{L_i\}_{i=1}^n\right),$$

Distorted market equilibrium still satisfies resource constraints

...and the, undistorted, technology and resource constraints

$$\begin{aligned} Y_i &= Z_i F_i \left(K_i, L_i, \{ M_{i,j} \} \right), \\ K &= \mathcal{K} \left(\{ K_i \} \right), \\ L &= \mathcal{L} \left(\{ L_i \} \right), \\ Y_i &= D_i + \sum_j M_{j,i}. \end{aligned}$$

Market equilibrium coincides with distorted planner allocation

Planner chooses $\{Y_i, L_i, K_i, M_{i,j}\}$ to maximize

$$D = \mathcal{G}(\{D_i\})$$

subject to the following constraints

$$\begin{aligned}
Y_i &= Z_i F_i\left(K_i, L_i, \{M_{i,j}\}\right) \\
\frac{1}{(1+\mu_i)} Y_i &= \left(1+\tau_i^D\right) D_i + \sum_i \left(1+\tau_j^i\right) M_{j,i} + \Theta_i^Y \\
K &= \sum_i \left(1+\tau_i^K\right) \theta_i^K K_i + \Theta^K \\
L &= \sum_i \left(1+\tau_i^L\right) \theta_i^L L_i + \Theta^L
\end{aligned}$$

Distortions such that aggregate resource constraints hold

Planner does *not internalize* that $\left\{\theta_i^K\right\}_{i=1}^n$, $\left\{\theta_i^L\right\}_{i=1}^n$, $\left\{\Theta_i^Y\right\}_{i=1}^n$, Θ^K, and Θ^L themselves depend on the planner's choices.

$$
\begin{aligned}
\theta_i^K &= \mathcal{K}_i \\
\theta_i^L &= \mathcal{L}_i \\
\Theta_i^Y &= -\frac{\mu_i}{(1+\mu_i)} Y_i - \tau_i^D D_i - \sum_j \tau_j^i M_{j,i} \\
\Theta^K &= \mathcal{K}\left(\{K_i\}\right) - \sum_i \left(1+\tau_i^K\right) \theta_i^K K_i \\
\Theta^L &= \mathcal{L}\left(\{L_i\}\right) - \sum_i \left(1+\tau_i^L\right) \theta_i^L L_i
\end{aligned}
$$

Advantage is that allocation is result of optimization problem

Planner's problem has the following associated Lagrangian

$$
\begin{aligned}
D &= \mathcal{G}\left(\{D_i\}\right) \\
&- \omega_i\left[Y_i - Z_iF_i\left(K_i, L_i, \{M_{i,j}\}\right)\right] \\
&+ \psi_i\left[\frac{1}{(1+\mu_i)}Y_i - \left(1+\tau_i^D\right)D_i - \sum_i\left(1+\tau_j^i\right)M_{j,i} - \Theta_i^Y\right] \\
&+ \kappa\left[K - \sum_i\left(1+\tau_i^K\right)\theta_i^K K_i - \Theta^K\right] \\
&+ \lambda\left[L - \sum_i\left(1+\tau_i^L\right)\theta_i^L L_i - \Theta^L\right]
\end{aligned}
$$

Planner's choice coincides with distorted market equilibrium

- Lagrange multipliers are related to the market prices in the following manner

$$\omega_i = \frac{1}{(1+\mu_i)} \frac{P_i}{P}, \ \psi_i = \frac{P_i}{P}, \ \kappa = \frac{R}{P}, \text{ and } \lambda = \frac{W}{P}$$

- Take time derivative of Planner's Lagrangian and exploit Envelope Theorem

Hulten (1978)

Behold the power of the Envelope Theorem!

$$
\begin{aligned}
\dot{d} \;=\; & \sum_i \frac{1}{(1+\mu_i)} \frac{P_i}{PD} Y_i \dot{z}_i + \frac{RK}{PD}\dot{k} + \frac{WL}{PD}\dot{l} \\
+ \; & \dot{d} + \sum_i \frac{\mu_i}{(1+\mu_i)} \frac{P_i Y_i}{PD} \dot{y}_i - \sum_i \left[\frac{P_i Y_i}{PD}\dot{y}_i - \sum_j \left(1+\tau_j^i\right) \frac{P_i M_{j,i}}{PD} \dot{m}_{j,i} \right] \\
- \; & \left[\frac{RK}{PD}\dot{k} - \sum_i \frac{R}{PD} \left(1+\tau_i^K\right) \mathcal{K}_i K_i \dot{k}_i \right] - \left[\frac{WL}{PD}\dot{l} - \sum_i \frac{W}{PD} \left(1+\tau_i^L\right) \mathcal{L}_i L_i \dot{l}_i \right]
\end{aligned}
$$

- Each part associated with separate distortion
- Does not depend on changes in distortions

Obtain a familiar decomposition after some substitutions...

$$\begin{aligned} \dot{v} &= \sum_i \frac{1}{(1+\mu_i)} s_i^D \dot{z}_i + s^K \dot{k} + s^L \dot{l} \\ &+ \sum_i s_i^D \frac{\mu_i}{(1+\mu_i)} \dot{y}_i + \sum_i s_i^V s_i^K \left(\dot{k}_i - \dot{k} \right) + \sum_i s_i^V s_i^L \left(\dot{l}_i - \dot{l} \right) \end{aligned}$$

Here, the value-added shares and Domar (1962) weights of sector i are given by

$$s_i^V = \frac{P_i^V V_i}{PV}, \text{ and } s_i^D = \frac{P_i Y_i}{PV},$$

and the aggregate and sector-specific factor shares equal

$$s^K = \sum_i s_i^V s_i^K, \text{ where } s_i^K = \frac{\left(1+\tau_i^K\right) R_i K_i}{P_i V_i} \text{ and } s^L = \sum_i s_i^V s_i^L, \text{ where } s_i^L = \frac{\left(1+\tau_i^L\right) W_i L_i}{P_i V_i}.$$

Normative reinterpretation of existing growth-accounting result

$$\dot{v} = \sum_i \frac{1}{(1+\mu_i)} s_i^D \dot{z}_i + s^K \dot{k} + s^L \dot{l} + \sum_i s_i^D \frac{\mu_i}{(1+\mu_i)} \dot{y}_i + \sum_i s_i^V s_i^K \left(\dot{k}_i - \dot{k}\right) + \sum_i s_i^V s_i^L \left(\dot{l}_i - \dot{l}\right)$$

- Equation similar to Jorgenson *et al.* (1987)
- Includes effect of changes in markups, as in Basu & Fernald (1997)
- Last two reallocation terms reflect shifts in misallocation in capital and labor markets

Global data on productivity:

Use WIOD-SEA data on country-industry level output and factor inputs.

Timmer (2012), Timmer *et al.* (2014), Timmer *et al.* (2015)

WIOD data allows for global growth accounting

WIOD data allows for global growth accounting

- 40 countries and 36 industries (1995-2014)
- Covering 80% of world GDP
- Two vintages 2013 & 2016
  - Similar set of countries
  - 2016 vintage has limited set of variables
  - Focus on qualitative results common across vintages

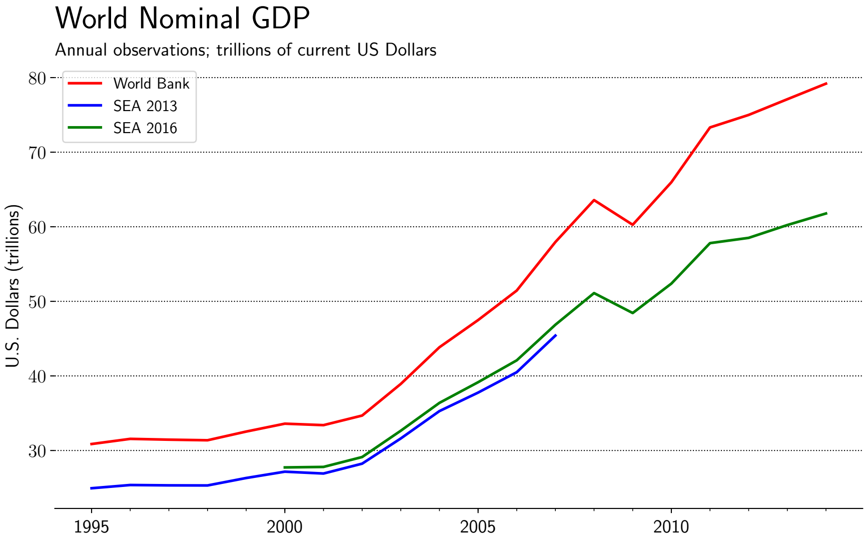
Timmer (2012), Timmer *et al.* (2014), Timmer *et al.* (2015)

- Construct markups using implicit return in user cost equation

Barkai (2016), Karabarbounis & Neiman (2018), Hall & Jorgenson (1969)

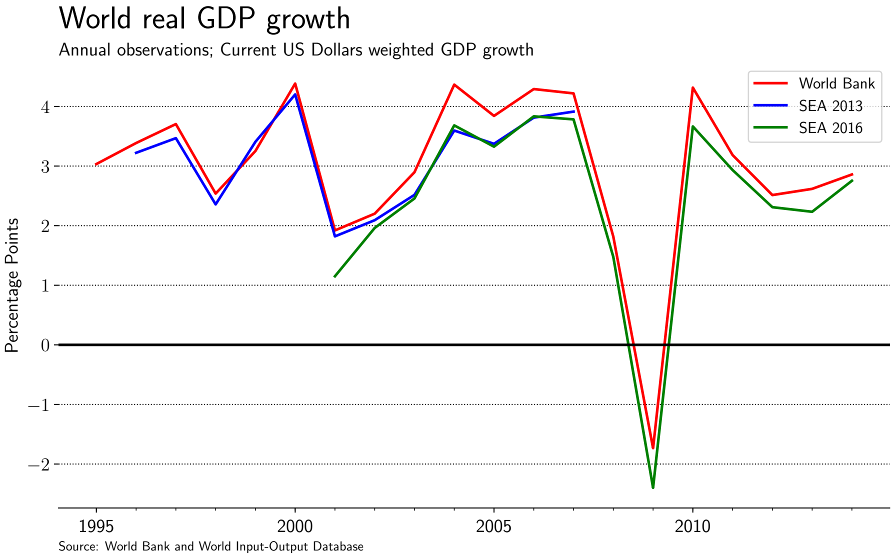
Regions Industries

WIOD captures most of worldwide economic activity



Source: World Bank and World Input-Output Database

Data captures bulk fluctuations in world GDP growth



Results for two measures of productivity

ALP: for both WIOD vintages (no need to use capital data)

TFP: for 2013 WIOD vintage (for which we have capital data)

Compare ALP decomposition for vintages

$$
\begin{aligned}
\dot{alp} &= \dot{v} - \dot{l} \\
&= \sum_i \left[s_i^V \dot{alp}_i - s_i^D \frac{\mu_i}{(1+\mu_i)} \dot{y}_i \right] + \sum_i s_i^D \frac{\mu_i}{(1+\mu_i)} \dot{y}_i \\
&+ \sum_i s_i^V s_i^L \left(\dot{l}_i - \dot{l} \right) + \sum_i s_i^V \left(1 - s_i^L \right) \left(\dot{l}_i - \dot{l} \right).
\end{aligned}
$$

Compare ALP decomposition for vintages

World ALP is output per hour growth

BLS Productivity and Cost

$$
\begin{aligned}
\dot{alp} &= \dot{v} - \dot{l} \\
&= \sum_i \left[s_i^V \dot{alp}_i - s_i^D \frac{\mu_i}{(1+\mu_i)} \dot{y}_i \right] + \sum_i s_i^D \frac{\mu_i}{(1+\mu_i)} \dot{y}_i \\
&+ \sum_i s_i^V s_i^L \left(\dot{l}_i - \dot{l} \right) + \sum_i s_i^V \left(1 - s_i^L \right) \left(\dot{l}_i - \dot{l} \right).
\end{aligned}
$$

Compare ALP decomposition for vintages

Country-industry specific ALP growth

$$
\begin{aligned}
\dot{alp} &= \dot{v} - \dot{l} \\
&= \sum_i \left[s_i^V \dot{alp}_i - s_i^D \frac{\mu_i}{(1+\mu_i)} \dot{y}_i \right] + \sum_i s_i^D \frac{\mu_i}{(1+\mu_i)} \dot{y}_i \\
&+ \sum_i s_i^V s_i^L \left(\dot{l}_i - \dot{l} \right) + \sum_i s_i^V \left(1 - s_i^L \right) \left(\dot{l}_i - \dot{l} \right).
\end{aligned}
$$

Compare ALP decomposition for vintages

Net out the effect of shifts in markups

$$
\begin{aligned}
\dot{alp} &= \dot{v} - \dot{l} \\
&= \sum_i \left[s_i^V \dot{alp}_i - s_i^D \frac{\mu_i}{(1+\mu_i)} \dot{y}_i \right] + \sum_i s_i^D \frac{\mu_i}{(1+\mu_i)} \dot{y}_i \\
&+ \sum_i s_i^V s_i^L \left(\dot{l}_i - \dot{l} \right) + \sum_i s_i^V \left(1 - s_i^L \right) \left(\dot{l}_i - \dot{l} \right).
\end{aligned}
$$

Compare ALP decomposition for vintages

$$
\begin{aligned}
\dot{alp} &= \dot{v} - \dot{l} \\
&= \sum_i \left[s_i^V \dot{alp}_i - s_i^D \frac{\mu_i}{(1+\mu_i)} \dot{y}_i \right] + \sum_i s_i^D \frac{\mu_i}{(1+\mu_i)} \dot{y}_i \\
&+ \sum_i s_i^V s_i^L \left(\dot{l}_i - \dot{l} \right) + \sum_i s_i^V \left(1 - s_i^L \right) \left(\dot{l}_i - \dot{l} \right).
\end{aligned}
$$

Reallocation of labor between countries with different ALP levels

Compare ALP decomposition for vintages

$$
\begin{aligned}
\dot{alp} &= \dot{v} - \dot{l} \\
&= \sum_i \left[s_i^V \dot{alp}_i - s_i^D \frac{\mu_i}{(1+\mu_i)} \dot{y}_i \right] + \sum_i s_i^D \frac{\mu_i}{(1+\mu_i)} \dot{y}_i \\
&+ \sum_i s_i^V s_i^L \left(\dot{l}_i - \dot{l} \right) + \sum_i s_i^V \left(1 - s_i^L \right) \left(\dot{l}_i - \dot{l} \right).
\end{aligned}
$$

Misallocation of labor normative term

World ALP growth fluctuates a lot

World ALP is output per hour growth

BLS Productivity and Cost

$$\begin{aligned}
\dot{alp} &= \dot{v} - \dot{l} \\
&= \sum_i \left[s_i^V \dot{alp}_i - s_i^D \frac{\mu_i}{(1+\mu_i)} \dot{y}_i \right] + \sum_i s_i^D \frac{\mu_i}{(1+\mu_i)} \dot{y}_i \\
&+ \sum_i s_i^V s_i^L \left(\dot{l}_i - \dot{l} \right) + \sum_i s_i^V \left(1 - s_i^L \right) \left(\dot{i}_i - \dot{i} \right)
\end{aligned}$$

Period	1996 -2000	2001 -2004	2005 -2007	2008 -2010	2011 -2014
World ALP growth	**2.15**	**0.07**	**3.31**	**0.98**	**-0.82**

Country-industry specific ALP growth relatively constant...

Country-industry specific ALP growth

$$\dot{alp} = \dot{v} - \dot{l}$$
$$= \sum_i \left[s_i^V \dot{alp}_i - s_i^D \frac{\mu_i}{(1+\mu_i)} \dot{y}_i \right] + \sum_i s_i^D \frac{\mu_i}{(1+\mu_i)} \dot{y}_i$$

Period	1996 -2000	2001 -2004	2005 -2007	2008 -2010	2011 -2014
World ALP growth	2.15	0.07	3.31	0.98	-0.82
Country-industry total	**2.14**	**2.11**	**2.20**	**1.70**	**0.67**

... but composition shifted towards emerging economies

Period	1996 -2000	2001 -2004	2005 -2007	2008 -2010	2011 -2014
Country-industry total	**2.14**	**2.11**	**2.20**	**1.70**	**0.67**
U.S.	0.75	1.01	0.42	0.54	-0.00
China	0.30	0.28	0.53	0.65	0.59
Japan	0.31	0.25	0.19	-0.08	0.06
Germany	0.11	0.08	0.13	0.01	0.03
France	0.12	0.07	0.05	0.04	0.05
U.K.	0.11	0.13	0.10	0.03	0.01
India	0.06	0.02	0.17	0.12	-0.11
Other Asia	0.11	0.08	0.27	0.01	-0.10
Other	0.28	0.18	0.34	0.37	0.14

Large part of ALP growth in 2000's reflects shift in markups

Country-industry specific ALP growth

$$\dot{alp} = \dot{v} - \dot{l}$$

Period	1996 -2000	2001 -2004	2005 -2007	2008 -2010	2011 -2014
Country-industry total	2.14	2.11	2.20	1.70	0.67
Shifts in markups	**-0.55**	**0.50**	**0.99**	**0.38**	**1.04**
Net of markups	2.69	1.16	1.21	1.31	-0.37

Large part of World ALP growth volatility is misallocation of labor

$$
\begin{aligned}
\dot{alp} &= \dot{v} - \dot{l} \\
&= \sum_i \left[s_i^V \dot{alp}_i - s_i^D \frac{\mu_i}{(1+\mu_i)} \dot{y}_i \right] + \sum_i s_i^D \frac{\mu_i}{(1+\mu_i)} \dot{y}_i \\
&+ \sum_i s_i^V s_i^L \left(\dot{l}_i - \dot{l} \right) + \sum_i s_i^V \left(1 - s_i^L \right) \left(\dot{l}_i - \dot{l} \right).
\end{aligned}
$$

Misallocation of labor normative term

Large part of World ALP growth volatility is misallocation of labor

Period	1996 -2000	2001 -2004	2005 -2007	2008 -2010	2011 -2014
World ALP growth	2.15	0.07	3.31	0.98	-0.82
Country-industry total	2.14	2.11	2.20	1.70	0.67
Misallocation	**-0.01**	**-1.34**	**0.50**	**-0.36**	**-0.97**
Other reallocation	0.03	-0.70	0.61	-0.35	-0.51

Misallocation of labor normative term

TFP decomposition for 2013 vintage for which we have capital data

$$
\begin{aligned}
\dot{tfp} &= \dot{v} - s^K \dot{k} - s^L \dot{l} \\
&= \sum_i \frac{1}{(1+\mu_i)} s_i^D \dot{z}_i + \sum_i s_i^D \frac{\mu_i}{(1+\mu_i)} \dot{y}_i \\
&+ \sum_i s_i^V s_i^K \left(\dot{k}_i - \dot{k}\right) + \sum_i s_i^V s_i^L \left(\dot{l}_i - \dot{l}\right).
\end{aligned}
$$

TFP decomposition for 2013 vintage for which we have capital data

World TFP is output growth minus share-weighted input growth

$$\begin{aligned} \dot{tfp} &= \dot{v} - s^K \dot{k} - s^L \dot{l} \\ &= \sum_i \frac{1}{(1+\mu_i)} s_i^D \dot{z}_i + \sum_i s_i^D \frac{\mu_i}{(1+\mu_i)} \dot{y}_i \\ &+ \sum_i s_i^V s_i^K \left(\dot{k}_i - \dot{k}\right) + \sum_i s_i^V s_i^L \left(\dot{l}_i - \dot{l}\right). \end{aligned}$$

TFP decomposition for 2013 vintage for which we have capital data

$$
\begin{aligned}
\dot{tfp} &= \dot{v} - s^K \dot{k} - s^L \dot{l} \\
&= \sum_i \frac{1}{(1+\mu_i)} s_i^D \dot{z}_i + \sum_i s_i^D \frac{\mu_i}{(1+\mu_i)} \dot{y}_i \\
&+ \sum_i s_i^V s_i^K \left(\dot{k}_i - \dot{k}\right) + \sum_i s_i^V s_i^L \left(\dot{l}_i - \dot{l}\right).
\end{aligned}
$$

"Pure technology": Country-industry specific levels of TFP growth

TFP decomposition for 2013 vintage for which we have capital data

$$
\begin{aligned}
\dot{tfp} &= \dot{v} - s^K \dot{k} - s^L \dot{l} \\
&= \sum_i \frac{1}{(1+\mu_i)} s_i^D \dot{z}_i + \sum_i s_i^D \frac{\mu_i}{(1+\mu_i)} \dot{y}_i \\
&+ \sum_i s_i^V s_i^K \left(\dot{k}_i - \dot{k}\right) + \sum_i s_i^V s_i^L \left(\dot{l}_i - \dot{l}\right).
\end{aligned}
$$

Impact of shifts in markups on measured value added growth

TFP decomposition for 2013 vintage for which we have capital data

$$\begin{aligned}\dot{tfp} &= \dot{v} - s^K \dot{k} - s^L \dot{l} \\ &= \sum_i \frac{1}{(1+\mu_i)} s_i^D \dot{z}_i + \sum_i s_i^D \frac{\mu_i}{(1+\mu_i)} \dot{y}_i \\ &+ \sum_i s_i^V s_i^K \left(\dot{k}_i - \dot{k}\right) + \sum_i s_i^V s_i^L \left(\dot{l}_i - \dot{l}\right).\end{aligned}$$

(Shifts in) Misallocation of capital

TFP decomposition for 2013 vintage for which we have capital data

$$
\begin{aligned}
\dot{tfp} &= \dot{v} - s^K \dot{k} - s^L \dot{l} \\
&= \sum_i \frac{1}{(1+\mu_i)} s_i^D \dot{z}_i + \sum_i s_i^D \frac{\mu_i}{(1+\mu_i)} \dot{y}_i \\
&+ \sum_i s_i^V s_i^K \left(\dot{k}_i - \dot{k}\right) + \sum_i s_i^V s_i^L \left(\dot{l}_i - \dot{l}\right).
\end{aligned}
$$

(Shifts in) Misallocation of labor

TFP results reveal small shifts in misallocation of capital

Period	1996 -2000	2001 -2004	2005 -2007
World TFP growth	1.96	0.52	2.86
Country-industry total	**2.44**	**1.38**	**1.41**
Misallocation of capital	**0.08**	**-0.03**	**-0.04**
Misallocation of labor	-0.01	-1.34	0.50
Shifts in markups	-0.55	0.50	0.99

Accounting for deviations from PPP

Deviations from PPP account for only a fraction of shifts in the misallocation of labor

Deviations from PPP bias proxies of relative marginal products

Concern: Misallocation of labor mismeasures relative marginal products of labor

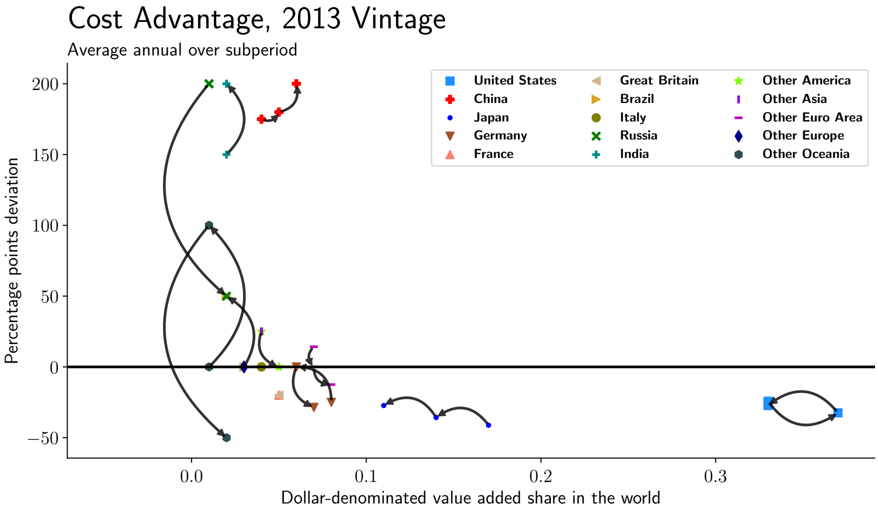
- Dollar-denominated value-added weights biased measures of relative marginal products of labor
- Deviations from PPP source of part of this bias
- Use new measures of value added in PPP for alternative set of results

Timmer *et al.* (2007)

Calculate impact of deviations from PPP on measure of misallocation of labor

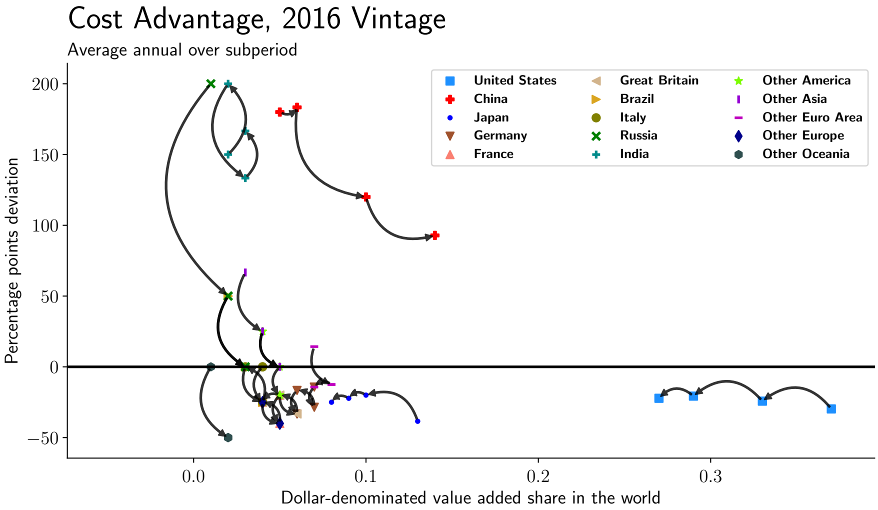
If there is a wedge between compensation share and PPP value added share in a location, then there is a cost advantage to produce in that location.

Asian producers have cost advantage due to deviations from PPP



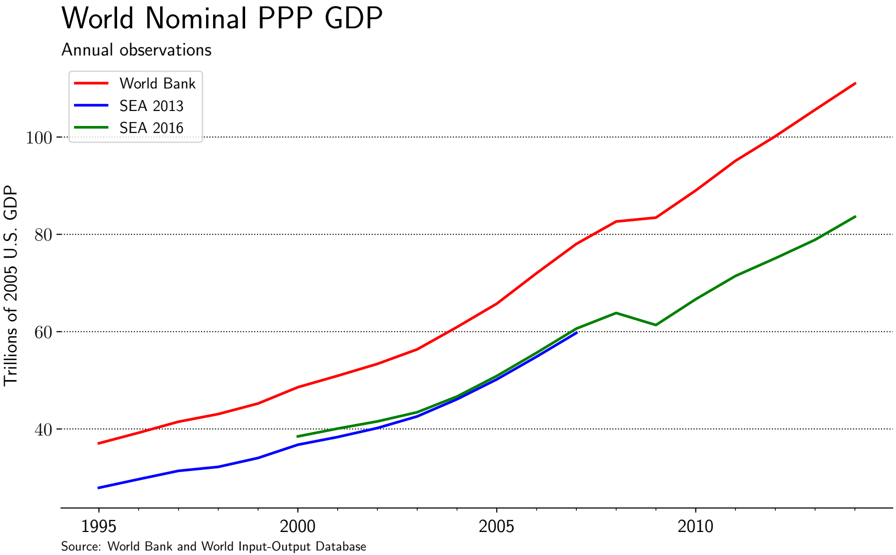
Source: SEA 2013, and authors' calculations

Asian producers have cost advantage due to deviations from PPP

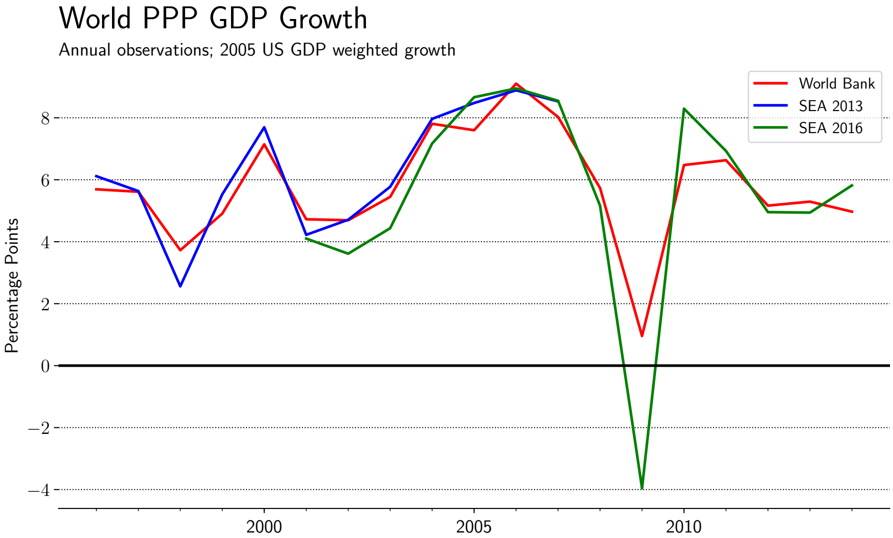


Source: SEA 2016, and authors' calculations

Data cover smaller part of world GDP PPP than in dollars



Data follow most of world GDP PPP growth fluctuations



Source: World Bank and World Input-Output Database

PPP-based ALP growth accounting

$$\begin{aligned}
\dot{alp}^* &= \sum_i s_i^{V*}\, \dot{alp}_i^* \\
&+ \sum_i \left(s_i^{V*} - s_i^V\right) s_i^L \left(\dot{l}_i - \dot{l}\right) + \sum_i \left(s_i^{V*} - s_i^V\right)\left(1 - s_i^L\right)\left(\dot{l}_i - \dot{l}\right) \\
&+ \sum_i s_i^V s_i^L \left(\dot{l}_i - \dot{l}\right) + \sum_i s_i^V \left(1 - s_i^L\right)\left(\dot{l}_i - \dot{l}\right).
\end{aligned}$$

World ALP-PPP growth

$$\dot{alp}^* = \sum_i s_i^{V*} \dot{alp}_i^* + \sum_i \left(s_i^{V*} - s_i^V\right) s_i^L \left(\dot{l}_i - \dot{l}\right) + \sum_i \left(s_i^{V*} - s_i^V\right)\left(1 - s_i^L\right)\left(\dot{l}_i - \dot{l}\right) + \sum_i s_i^V s_i^L \left(\dot{l}_i - \dot{l}\right) + \sum_i s_i^V \left(1 - s_i^L\right)\left(\dot{l}_i - \dot{l}\right).$$

PPP-based ALP growth accounting

Country-industry specific ALP-PPP growth

$$
\begin{aligned}
\dot{alp}^{*} &= \sum_i s_i^{V*}\, \dot{alp}_i^{*} \\
&+ \sum_i \left(s_i^{V*} - s_i^{V}\right) s_i^{L} \left(\dot{l}_i - \dot{l}\right) + \sum_i \left(s_i^{V*} - s_i^{V}\right) \left(1 - s_i^{L}\right) \left(\dot{l}_i - \dot{l}\right) \\
&+ \sum_i s_i^{V} s_i^{L} \left(\dot{l}_i - \dot{l}\right) + \sum_i s_i^{V} \left(1 - s_i^{L}\right) \left(\dot{l}_i - \dot{l}\right).
\end{aligned}
$$

PPP-based ALP growth accounting

$$
\begin{aligned}
\dot{alp}^* &= \sum_i s_i^{V*} \dot{alp}_i^* \\
&+ \sum_i \left(s_i^{V*} - s_i^V\right) s_i^L \left(\dot{l}_i - \dot{l}\right) + \sum_i \left(s_i^{V*} - s_i^V\right)\left(1 - s_i^L\right)\left(\dot{l}_i - \dot{l}\right) \\
&+ \sum_i s_i^V s_i^L \left(\dot{l}_i - \dot{l}\right) + \sum_i s_i^V \left(1 - s_i^L\right)\left(\dot{l}_i - \dot{l}\right).
\end{aligned}
$$

Misallocation by deviation from PPP

PPP-based ALP growth accounting

$$
\begin{aligned}
\dot{alp}^{*} &= \sum_i s_i^{V*}\,\dot{alp}_i^{*} \\
&+ \sum_i \left(s_i^{V*} - s_i^{V}\right) s_i^{L} \left(\dot{l}_i - \dot{l}\right) + \sum_i \left(s_i^{V*} - s_i^{V}\right)\left(1 - s_i^{L}\right)\left(\dot{l}_i - \dot{l}\right) \\
&+ \sum_i s_i^{V} s_i^{L} \left(\dot{l}_i - \dot{l}\right) + \sum_i s_i^{V}\left(1 - s_i^{L}\right)\left(\dot{l}_i - \dot{l}\right).
\end{aligned}
$$

Misallocation of labor based on dollar-denominated value added shares

Deviations from PPP only a fraction of shifts in misallocation of labor

Period	1996 -2000	2001 -2004	2005 -2007	2008 -2010	2011 -2014
World ALP growth	2.15	0.07	3.31	0.98	-0.82
World ALP-PPP growth	4.09	3.08	8.20	3.52	2.60
Country-industry total	3.84	4.67	6.58	3.56	3.24
Deviations from PPP					
Misallocation	**0.15**	**0.27**	**0.10**	**0.34**	**0.49**
Other reallocation	0.10	0.21	0.34	0.37	0.31
Dollar-denominated previously shown					
Misallocation	**-0.01**	**-1.34**	**0.50**	**-0.37**	**-0.95**
Other reallocation	0.03	-0.70	0.64	-0.38	-0.49

Deviations from PPP only a fraction of shifts in misallocation of labor

Deviations from PPP account for only about a third of shifts in the misallocation of labor across countries

Period	1996 -2000	2001 -2004	2005 -2007	2008 -2010	2011 -2014
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	-0.82
World ALP-PPP growth	4.09	3.08	8.20	3.52	2.60
Country-industry total	3.84	4.67	6.58	3.56	3.24
Deviations from PPP					
Misallocation	**0.15**	**0.27**	**0.10**	**0.34**	**0.49**
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Dollar-denominated previously shown					
Misallocation	**-0.01**	**-1.34**	**0.50**	**-0.37**	**-0.95**
Other reallocation	0.03	-0.70	0.64	-0.38	-0.49

For those who are finally paying attention...
or still are...

Conclusion

Introduce normative growth-accounting decomposition

- Market allocation with distortions in product, capital, and labor markets
- Normative reinterpretation of conventional growth accounting terms

Decompose both world ALP and TFP growth

- Use World Input-Output Tables data
- Construct country-industry level PPP data to quantify international cost advantages

Provide a new high-level picture of global productivity growth

- **Fluctuations** World ALP and TFP growth fluctuates a lot
- **Misallocation** Misallocation of labor net drag and main source of global productivity growth fluctuations
- **Country-industry level productivity growth** Country-industry level contributions relatively constant

Reference slides

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Regional classification of countries

Classification	Country
United States	
China	
Japan	
Germany	
France	
Great Britain	
Brazil	
Italy	
Russia	
India	
Other America	Canada and Mexico
Other Asia	Indonesia, Republic of Korea, Turkey and Taiwan
Other Euro Area	Austria, Belgium, Cyprus, Spain, Estonia, Finland, Greece, Ireland, Lithuania, Luxemberg, Latvia, Malta, Netherlands, Norway, Portugal, Slovakia, Slovenia
Other Europe	Bulgaria, Croatia, Czech Republic, Denmark, Hungary, Poland, Romania, Sweden, Switzerland
Other Oceania	Australia

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Industry Classification

Classification	NAICS
Agriculture	Agriculture, Forestry, Fishing and Hunting, Mining
Construction	Construction
Nondurable manufacturing	Manufacturing
Durable manufacturing	Manufacturing
Trade, transportation and utilities	Wholesale Trade, Retail Trade, Transportation and Warehousing, Utilities
Finance, insurance and real estate (FIRE)	Finance and Insurance, Real Estate Rental and Leasing
Business services	Information, Professional, Scientific, and Technical Services, Management of Companies and Enterprises
Education and healthcare	Educational Services, Health Care and Social Assistance
Hospitality	Accommodation and Food Services
Personal services	Arts, Entertainment, and Recreation, Other Services, Administrative and Support and Waste Management and Remediation Services
Government	Public Administration
Households	

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