# World Productivity: 1996 - 2014
# Online Appendix

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## 1 Accounting for within- and across-country contributions

As mentioned in the main text, we split up the contribution of reallocation terms into with-country component and across-country one. We elaborate here how we do this, focusing on equation (11).

Remember that the index $i$ in equation (11) represents a country-industry pair. We rewrite this equation again with a new indexation: $i$ for industry and $c$ for country:

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$$\begin{aligned}\dot{v} &= \sum_c \sum_i \frac{1}{(1+\mu_{ci})} s^D_{ci} \dot{z}_{ci} + s^K \dot{k} + s^L \dot{l} \\ &+ \sum_c \sum_i s^D_{ci} \frac{\mu_{ci}}{(1+\mu_{ci})} \dot{y}_{ci} + \sum_c \sum_i s^V_{ci} s^K_{ci} \left( \dot{k}_{ci} - \dot{k} \right) + \sum_c \sum_i s^V_{ci} s^L_{ci} \left( \dot{l}_{ci} - \dot{l} \right).\end{aligned} \tag{1}$$

We can now split up the capital and labor reallocation terms into within- and across-country component. For example, labor reallocation term can be written as

$$\sum_c \sum_i s^V_{ci} s^L_{ci} \left( \dot{l}_{ci} - \dot{l} \right) = \sum_c s^V_c \sum_i \frac{s^V_{ci} s^L_{ci}}{s^V_c} \left( \dot{l}_{ci} - \dot{l}_c \right) + \sum_c s^V_c s^L_c \left( \dot{l}_c - \dot{l} \right), \tag{2}$$

where

$$s^L_c = \left( \frac{\sum_i s^V_{ci} s^L_{ci}}{s^V_c} \right), \text{ and } s^V_c = \sum_i s^V_{ci}. \tag{3}$$

Equation (2) splits up the labor reallocation terms into two parts: within-country reallocation of labor which is the first term on the RHS, and across-country component which is the second term. A positive within-country reallocation of labor states that hours are growing faster in industries that on average have higher labor share and contribute more to the country GDP. Higher labor share means that the wages are on average higher in these industries which indicates higher marginal product of labor. Hence, a positive term means that there are productivity gains from reallocation of labor within the country.

Similarly, a positive across-country reallocation means that hours are growing faster in countries with higher labor share and contribute more to world GDP. The capital reallocation term can be split up similarly.

## 2 ANOVA of wages

To quantify the importance of cross-country wage differentials versus within-country cross-industry wage differentials, we can do an ANOVA. Define the average global wage as

$$W_t = \sum_i \frac{W_i L_i}{L} = \sum_i \omega_i W_i, \text{ where } L = \sum_i L_i,\ \omega_i = \frac{L_i}{L} \tag{4}$$

We will decompose the variance of this average wage across country-industry combinations. This variance is given by

$$\sigma^2 = \sum_i \omega_i \left(W_i - W\right)^2 = \sum_i \omega_i W_i^2 - W^2. \tag{5}$$

We split this variance into within-country, $c$, variation and between-country variation in the following way. Let the average wage paid in country $c$ to skill-level $\tau$ be equal to

$$W_{c,\tau} = \sum_{i\in c} \frac{W_{i,\tau} L_{i,\tau}}{L_{c,\tau}} = \sum_{i\in c} \omega_{i,\tau} W_{i,\tau}, \text{ where } L_{c,\tau} = \sum_{i\in c} L_{i,\tau},\ \omega_{i,\tau} = \frac{L_{i,\tau}}{L_{c,\tau}}, \tag{6}$$

and let the average hourly wage paid to workers with skill level $\tau$ be

$$W_\tau = \sum_i \frac{W_{c,\tau} L_{c,\tau}}{L_\tau} = \omega_{c,\tau} W_{c,\tau}, \text{ where } \omega_{c,\tau} = \frac{L_{c,\tau}}{L_\tau},\ \omega_\tau = \frac{L_\tau}{L}, \text{ and } L_\tau = \sum_i L_{i,\tau}. \tag{7}$$

We can then write

$$\begin{aligned}
\sigma^2 &= \sum_\tau \sum_c \sum_{i\in c} \omega_i \left[(W_{i,\tau} - W_{c,\tau}) + (W_{c,\tau} - W_\tau) + (W_\tau - W)\right]^2 \\
&= \sum_\tau \sum_c \sum_{i\in c} \omega_i \left[(W_{i,\tau} - W_{c,\tau})^2 + (W_{c,\tau} - W_\tau)^2 + (W_\tau - W)^2\right] + \\
&\quad 2\sum_\tau \sum_c \sum_{i\in c} \omega_i \left[(W_{i,\tau} - W_{c,\tau})(W_{c,\tau} - W_\tau) + (W_{i,\tau} - W_{c,\tau})(W_\tau - W)\right] + \\
&\quad 2\sum_\tau \sum_c \sum_{i\in c} \omega_i \left[(W_{c,\tau} - W_\tau)(W_\tau - W)\right] \\
&= \sum_\tau \sum_c \sum_{i\in c} \omega_i \left[(W_{i,\tau} - W_{c,\tau})^2 + (W_{c,\tau} - W_\tau)^2 + (W_\tau - W)^2\right] \\
&= \sum_\tau \omega_\tau \sum_c \frac{\omega_{c,\tau}}{\omega_\tau} \sum_{i\in c} \frac{\omega_{i,\tau}}{\omega_{c,\tau}} (W_{i,\tau} - W_{c,\tau})^2 + \sum_\tau \omega_\tau \sum_c \frac{\omega_{c,\tau}}{\omega_\tau} (W_{c,\tau} - W_\tau)^2 + \sum_\tau (W_\tau - W)^2 \\
&= \sigma^2_{i,c,\tau} + \sigma^2_{c,\tau} + \sigma^2_\tau.
\end{aligned}$$

The problem is that the above measure is dependent on units of observation, which actually change over time. So, we need a transformation that gets rid off that. For that we, use the square of coefficient of variation, $\frac{\sigma}{\mu}$. So, that yields

$$\left(\frac{\sigma}{W}\right)^2 = \left(\frac{W_{c,\tau}}{W}\right)^2 \left(\frac{\sigma_{i,c,\tau}}{W_{c,\tau}}\right)^2 + \left(\frac{W_\tau}{W}\right)^2 \left(\frac{\sigma_{c,\tau}}{W_\tau}\right)^2 + \left(\frac{\sigma_\tau}{W}\right)^2. \tag{8}$$

The alternative is to use shares and calculate at each point in time

$$1 = \frac{\sigma^2_{i,c,\tau}}{\sigma^2} + \frac{\sigma^2_{c,\tau}}{\sigma^2} + \frac{\sigma^2_\tau}{\sigma^2} \tag{9}$$

and then average these shares over time and report them in the table.

We can do this for every year and determine what fraction of the variation in wages is due to within country differences and what fraction is due to cross-country differences. We can also relate this to percentage differences in wages.

# 3 Growth accounting with labor skill levels

Let $\tau \in \{L, M, H\}$ denotes the three labor inputs based on skill. Our raw accounting identity is the following (equation (10) in the main text):

$$\dot{v} = \sum_i \frac{1}{(1+\mu_i)} s_i^D \dot{z}_i + \sum_i s_i^V s_i^K \dot{k}_i + \sum_i s_i^V s_i^L \dot{l}_i + \sum_i s_i^D \frac{\mu_i}{(1+\mu_i)} \dot{y}_i. \tag{10}$$

Before rearranging this equation to get equation (11), we can manipulate the labor term to reflect labor quality. Assuming we have three categories for labor (Low, Medium, and High skilled), the above equation would be:

$$\dot{v} = \sum_i \frac{1}{(1+\mu_i)} s_i^D \dot{z}_i + \sum_i s_i^V s_i^K \dot{k}_i + \sum_i \sum_{\tau \in \{L,M,H\}} s_i^V s_i^{L\tau} \dot{l}_i^\tau + \sum_i s_i^D \frac{\mu_i}{(1+\mu_i)} \dot{y}_i. \tag{11}$$

We now add and subtract aggregate share-weighted factor growth to this equation. For labor, there are three types of aggregate workers, so we add and subtract $\sum_{\tau \in \{L,M,H\}} s^{L\tau} \dot{l}^\tau = \sum_{\tau \in \{L,M,H\}} \sum_i s_i^V s_i^{L\tau} \dot{l}^\tau$. We arrive at the modified version of the main equation:

$$\begin{aligned} \dot{v} &= \sum_i \frac{1}{(1+\mu_i)} s_i^D \dot{z}_i + s^K \dot{k} + \sum_{\tau \in \{L,M,H\}} s^{L\tau} \dot{l}^\tau \\ &+ \sum_i s_i^D \frac{\mu_i}{(1+\mu_i)} \dot{y}_i + \sum_i s_i^V s_i^K \left(\dot{k}_i - \dot{k}\right) + \sum_{\tau \in \{L,M,H\}} \sum_i s_i^V s_i^{L\tau} \left(\dot{l}_i^\tau - \dot{l}^\tau\right). \end{aligned} \tag{12}$$

The final term is the change in labor reallocation. It is now the weighted average of labor reallocation across the three types of labor. Aggregate and industry TFP also change, because we now allow for shifts in the contribution of aggregate labor quality. For aggregate TFP, these shifts show up in the share-weighted growth in labor input in the final term on the first line. For industry TFP, we were previously attributing to technology a part of each industry's growth that is due to labor shifting among education groups.

To see the contribution of labor quality more explicitly, note that the aggregate labor share, $s^L$, is the sum of the labor shares across the three types of labor, $\sum_{\tau\in\{L,M,H\}} s^{L\tau}$. Hence, following Jorgenson *et al.* (1987), we can write the contribution-of-aggregate-labor term in the first line as the sum of share-weighted hours growth plus the change in aggregate labor quality:

$$\sum_{\tau\in\{L,M,H\}} s^{L\tau}\dot{l}^{\tau} = s^{L}\dot{l} + \sum_{\tau\in\{L,M,H\}} s^{L\tau}\left(\dot{l}^{\tau}-\dot{l}\right) \tag{13}$$

Returning to the labor reallocation term, it will be useful for intuition to express it a different way. First, define the average wage for each type of worker as $W^{\tau} = \left(\sum_i W_i^{\tau}L_i^{\tau}\right)/L^{\tau}$. Second, note that growth in hours of type $\tau$ is

$$\dot{l}^{\tau} = \sum_i \left(\frac{L_i^{\tau}}{L^{\tau}}\right)\dot{l}_i^{\tau} = \sum_i \left(\frac{W^{\tau}L_i^{\tau}}{W^{\tau}L^{\tau}}\right)\dot{l}_i^{\tau}. \tag{14}$$

We can now return to the definition of the labor reallocation term, and substitute in for $\dot{l}^{\tau}$. We find:

$$\begin{aligned}\sum_{\tau\in\{L,M,H\}}\left(\left(\sum_i s_i^V s_i^{L\tau}\dot{l}_i^{\tau}\right) - s^{\tau}\dot{l}^{\tau}\right) &= \sum_{\tau\in\{L,M,H\}}\left(\sum_i \frac{W_i^{\tau}L_i^{\tau}}{PV}\dot{l}_i^{\tau} - \sum_i \frac{W^{\tau}L_i^{\tau}}{PV}\dot{l}_i^{\tau}\right)\\ &= \sum_{\tau\in\{L,M,H\}}\sum_i\left(\frac{\left(W_i^{\tau}-W^{\tau}\right)L_i^{\tau}}{PV}\right)\dot{l}_i^{\tau} \end{aligned}\tag{15}$$

Our earlier intuition for labor reallocation was that, if labor grows faster in country-industries where it has a higher than average wage, then this is an improvement in reallocation. Other things equal, that shift boosts growth in output and aggregate TFP. With multiple types of labor, the nuance is that the shift has to take place within a given type of labor. This difference may matter in the data. For example, suppose we see a shift in the data from labor in advanced economies to labor in emerging markets. A part of cross-country wage differential in our earlier equation presumably reflects differences in the mix of skills across countries–so we need to compare the shifts within skill groups.[1]

# 4 Detailed results and data

## 4.1 Detailed results

### 4.1.1 Comparison with World-Bank aggregates

Figure 1 shows how nominal GDP in our data, measured in current US$, lines up with world GDP. The short-dashed line shows the level of nominal GDP in our sample countries in the 2013 vintage of the data. The other dashed line is the 2016 vintage of the data. Both of these lines are below the World GDP solid line, reflecting that our sample of countries covers about 80 percent of global economic activity (in dollars). The 2016 vintage is a bit higher in the overlapping period because of the inclusion of Croatia, Norway, and Switzerland.

Our time series for PPP-deflated world GDP growth lines up closely with that published by the World Bank in World Bank (2018). This is evident in Figures 2 and 3, which show the World GDP-PPP and its growth in our data versus that of the World Bank.

[1] The same intuition holds for capital reallocation. Capital reallocation reflects differential user costs across country-industries for computers, or for machine tools, or for office buildings. The reason we think the capital-reallocation term should be small with an external user cost is that the user cost differences should presumably be small. Of course, there could still be differences to the extent we treat the capital-gains term as country-industry specific, or if there are differential tax wedges.

#### 4.1.2 Value-added and factor shares by country and industry

Dollar-denominated value-added shares for the different periods by country and industry are reported in Tables 1 and 3, respectively. Similar PPP-weighted shares are listed in Tables 2 and 4, respectively. Profit shares by industry are reported in Table 5.

#### 4.1.3 Detailed contributions to world Total Factor Productivity (TFP) growth

The contributions of country-industry TFP growth, $\dot{z}_i$, by country/region for calculations based on dollar-weighted world GDP without taking into account markups are listed in 6, while these contributions with markups are in Table 4. The contribution of shifts in markups by region is reported in Table 7 while the same contribution by industry can be found in Table 8.

#### 4.1.4 Results for TFP with PPP-deflated data and for the Average Labor Productivity (ALP)

**PPP value-added share weighted results** A striking takeaway from our results in the main text is that labor reallocation explains much of the volatility in world TFP, as well as being a consistent drag on world growth. For this result, we valued world output using current dollars. A natural question is whether these findings reflect true differences in labor's marginal productivity across countries, or rather the effects of exchange rates? Table 9 addresses this question by quantifying the impact of deviations from Purchasing Power Parity (PPP) on the decomposition in equation (11). Here, country-industry value-added shares are measured in terms of 2005 PPP dollars rather than current U.S. dollars. Although the specific numbers are quite different, our qualitative results are robust to deviations from PPP.

Line 1 of Table 9 shows that PPP-weighted world GDP grows much faster than current-dollar-weighted GDP growth. The reason is that PPP value-added shares in world GDP tend to be higher than dollar shares for emerging economies; these economies tend to grow faster than average. The growth rate also appears somewhat more volatile. In contrast, comparing lines 2 and 3 with the same lines in Table 3, the contributions of aggregate capital and labor growth are not much changed.[2]

World TFP growth, reported in Line 4, is higher for the PPP-weighted case than for the dollar-weighted case. This follows from having faster growth in GDP (line 1) along with roughly similar contributions from capital and labor (lines 2 and 3). World TFP growth remains highly volatile across subperiods as well as slows down after 2007.

Comparing Lines 4 and 14 of Table 9 we find that fluctuations in PPP-deflated world TFP growth are much larger than those in country-industry PPP-deflated TFP growth. This is similar to what we found for dollar-weighted ALP and TFP growth as well (and was our first two takeaways). Moreover, even though level of country-industry TFP growth is higher in the PPP-weighted data, the pattern over time is similar to the dollar-weighted results.

Deviations from PPP do have a marked impact on the contributions of capital and labor reallocation, especially across countries, to world GDP growth. The impact of the cross-country capital reallocation in Line 7 of Table 9 is large compared to that in Table 3, in which it was negligible. This potentially reflects that capital flows across the world to equate dollar-denominated returns on investment across country-industry combinations. Equating these dollar-denominated returns is not the same as equating physical marginal products.

For the changes in labor reallocation we find the opposite. Labor reallocation is less important when we consider the PPP-weighted results in Table 9. A portion of cross-country labor reallocation in the dollar-weighted results in Table 3 reflects

[2]The numbers do not match exactly since our sample changed slightly due to PPP data availability. See Table 13 in Appendix 4.2 for more details.

economic activity shifting to sectors with an international cost advantage. These are industries with low relative wages compared to relative productivity levels—most obviously, manufacturing in China and India.

The labor reallocation results imply that deviations from PPP only account for about a third of the total impact of labor reallocation reported in the earlier tables. Thus, even after adjusting for PPP, labor reallocation remains a drag on world GDP growth as well as being an important source of volatility in world TFP.

Finally, shifts in markups (line 11) contribute slightly more to world GDP growth when PPP-deflated than current-dollar weighted. This is largely due to markups in (Chinese) manufacturing.

**World labor productivity growth** A popular way to measure productivity is to do a decomposition that uses the most reliably measured components. Namely, we are going to consider ALP growth and ignore markups. This relies only on value-added and hours growth.

To begin, recall that $\dot{v} = \sum_i s_i^V \dot{v}_i$ and, trivially, note that world labor growth, $\dot{l}$, equals $\sum_i s_i^V \dot{l}$. Using these expressions, and subtracting and adding $\sum_i s_i^V \dot{l}_i$, we can write world ALP growth as

$$\dot{alp} = \dot{v} - \dot{l} \;=\; \sum_i s_i^V \dot{alp}_i + \sum_i s_i^V \left(\dot{l}_i - \dot{l}\right) \tag{16}$$

Here, the first term on the right-hand side is the contribution of country-industry specific ALP growth. The second term reflects shifts in hours growth across country-industries. Some algebraic manipulation shows that the second term can be written as $\sum_i \left(\frac{L_i}{L}\right)\left(\frac{P_i^V V_i/L_i}{P^V V/L} - 1\right)\dot{l}_i$,[3] which will, in general, be nonzero if nominal value added per hour worked differs across country-industries. Nominal value added per hour

[3]To see this, note that, since $\sum_i s_i^V = \sum_i \frac{P_i^V V}{P^V V} = 1$ and $\dot{l} = \sum_i (L_i \,/\, L)\,\dot{l}_i$, we can write the second term on the right-hand-side of (16) as $\sum_i \left(\frac{P_i^V V}{P^V V} - L_i/L\right)\dot{l}_i = \sum_i \left(\frac{L_i}{L}\right)\left(\frac{P_i^V V_i/L_i}{P^V V/L} - 1\right)\dot{l}_i$.

worked might, in turn, differ across country-industries for efficient reasons (such as differences in factor shares) or because of wedges (such as factor-price wedges or markups). For this reason, it is useful to decompose the shift-in-hours term into two pieces:

$$\sum_i s_i^V \left(\dot{l}_i - \dot{l}\right) = \sum_i s_i^V s_i^L \left(\dot{l}_i - \dot{l}\right) + \sum_i s_i^V \left(1 - s_i^L\right) \left(\dot{l}_i - \dot{l}\right). \tag{17}$$

The first piece is the labor-reallocation term from equation (11); as discussed in Section IV, this term may be non-zero if there are wage differences across country-industries. In case of a statically efficient allocation of resources, this term would be zero. The second piece is a residual, reflecting other differences in factor shares or markups that may affect nominal value-added per hour (which might or might not be efficient).

In this section, we implement the world ALP decomposition in equation (16). We begin graphically with Figure 4, which illustrates the three key takeaways that we highlighted throughout our analysis. This is figure is basically the ALP version of Figure 3.

First, the dark lines in the figure show the substantial volatility in world ALP growth, $\dot{v} - \dot{l}$. Second, the light lines show the much smoother contribution of country-industry ALP growth, $\sum_i s_i^V \dot{alp}_i$. For example, the country-industry growth rate stays relatively constant in the 2003-2007 period; and it drops much less than world ALP growth in 2009 or 2011. Algebraically, equation (16) shows that the difference between the two lines reflects shifts in hours across industries with different levels of labor productivity, $\sum_i s_i^V \left(\dot{l}_i - \dot{l}\right)$. This effect includes the contribution of labor reallocation, $\sum_i s_i^V s_i^L \left(\dot{l}_i - \dot{l}\right)$. The third takeaway is the year-to-year volatility of this labor reallocation term, which explains much of the difference between the volatile world ALP growth and the smooth country-industry labor productivity growth.

Table 11 shows the detailed subperiod numbers for the two vintages. The rows correspond to components of equation (16). Line 1 of the table shows world GDP growth in each period. During the Great Recession period (2008-10, shown in the 2016 vintage), output grows much more slowly than in any previous period; it is followed by a sizeable recovery in 2011-14. Line 2 shows growth in world hours. Comparing the 2001-2004 and 2005-2007 periods across vintages, one can see the discrepancy in hours growth across vintages that we discussed in Subsection II.A. Specifically, world growth in hours in the 2016 vintage was about 0.77 percentage points lower from 2001-04 than in the 2013 vintage, but then was about 0.25 percentage point higher from 2005-07. These revisions, though large, do not substantially affect the key takeaways from this section.

Lines 3, 4, and 8 show the key takeaways from implementing equation (16). Line 3 shows World ALP growth, which is output growth (line 1) less hours growth (line 2). Lines 4 and 8 decompose this growth into (line 8) the part that reflects country-industry ALP growth, $\sum_i s_i^V \dot{alp}_i$; and (line 4) the part that reflects shifts in hours across country-industries, $\sum_i s_i^V \left(\dot{l}_i - \dot{l}\right)$. By construction, line 3 is the sum of lines 4 and 8.

Line 3 shows the first key takeaway: World ALP growth is volatile across the five subperiods that we distinguish. During the expansion of the late 1990's, world ALP growth was above 2 percent. Growth declined substantially in the early 2000's and (in both vintages) rebounded sharply in the mid-2000's. During the Great Recession (2008-10), world ALP growth retreated to under 1 percent per year. In the 2011-14 period, world ALP growth got even worse, turning sharply negative.

Line 8 shows the second key takeaway, which is the relatively smooth evolution of ALP growth at a country-industry level, $\sum_i s_i^V \dot{alp}_i$. Indeed, country-industry ALP growth was relatively constant at about 2 percent per year—regardless of which vintage you look at—over the first four of the five subperiods we consider. A sharp deterioration in country-industry ALP growth is apparent only in the final 2011-14 subperiod. Even there, country-industry growth remains positive, despite the sharply negative growth rate in world ALP from line 3.

The third takeaway, from lines 4 and 5, is that the bulk of the variation in world ALP growth arises from substantial volatility in the effects of shifting hours, notably labor reallocation. This follows from the first two takeaways, given that the contribution of shifting hours (line 4) is, as an accounting identity, the difference between the volatile growth rate of world ALP growth and the relatively smooth contribution of country-industry specific ALP.

As discussed in section IV, this shift-in-hours term reflects the cross-sectional covariance of labor growth and nominal value added per hour. Those differences could be efficient—reflecting, say, technological heterogeneity in factor shares across industries. Or they could be related to wedges, such as markups or labor taxes. For this reason, line 5 of Table 11 breaks out labor reallocation, $\sum_i s_i^V s_i^L \left(\dot{l}_i - \dot{l}\right)$. This piece, as discussed in Section IV, reflects the cross-sectional covariance of wages and labor growth. This labor-reallocation term in line 5 carries over to the TFP decompositions in the main text.

Within labor reallocation, what turns out to be quantitatively most important is reallocations across countries, reported in line 7 of the table. These shifts are, on average, a drag on world GDP growth of between around 0.4 and 0.5 percentage points. This reflects the fact that hours growth in emerging economies, where wages are lower, has typically outpaced hours growth in developed economies. The first-order conditions interpret these shifts as a reallocation of labor from high to low marginal-product-of-labor countries, as valued using measured prices. This cross-country term was slightly positive during the expansion in developed economies from 2005-2007. In contrast, the term was more negative in periods when there was a bigger wedge in hours growth between emerging and developed economies, as in 2001-2004, 2008-2010, and 2011-2014. Note also, from line 6, that shifts in the within-country reallocation of labor contribute little to world GDP growth.

Table 12 decomposes the contribution of country-industry ALP growth into its regional composition. It shows that the *composition* of this component across countries has changed notably over time. In terms of the cross-country details, these results are in line with studies that document a broad productivity slowdown in industrialized countries starting in the early 2000's (e.g., Cette *et al.*, 2016). We find that the contribution of country-industry specific ALP growth of these countries (United States, Japan, and the United Kingdom in particular) declines in the last three periods in our sample that cover 2005-2014. The global productivity impact of this slowdown was largely offset by an increase in the contributions of country-industry specific ALP growth to world GDP growth of Brazil, Russia, India, and China (BRIC countries). The contribution of BRIC countries' country-industry specific ALP to world productivity growth declined during 2011-2014. This, together with country-industry specific ALP growth in the United States, is the main driver of the decline in world ALP growth during that period.

What this result points out is how important it is to do growth accounting on a global scale to understand shifts in the center of gravity of global productivity growth. This is especially important during the 1996-2014 period that we consider, because of the growth performance of emerging economies in Asia.

## 4.2 Data

### 4.2.1 Countries and industries

The countries in each of the vintages as well as in the sample for PPP results are listed in Table 13. Throughout, we present these results for a set of regions that are the same across both vintages. The regions are listed in Table 14. The industries were classified into major categories, listed in Table 15, in order to be consistent with the North American Industry Classification System (NAICS).

### 4.2.2 Main variables used for our analysis

- **Gross Value Added**: This is the gross value added at current basic prices (in millions of national currency). The volume index which is normalized to 100 in 1995 and the price level normalized to 100 in 1995 are provided in the tables. The volume index of gross value added is the foundation of GDP growth calculation. We use the exchange rates provided in WIOD to express the nominal values in current U.S. Dollars. These exchange rates, however, are not PPP adjusted.

- **Labor**: Number of employees (thousands) and total hours worked by persons engaged (millions) provide information on the growth in hours along with misallocation of labor across countries and industries. It should be mentioned that the data on hours worked in China were imputed for the period 2008-2014 from the International Labor Organization (ILO).[4] In Socio-Economic Accounts (SEA) 2013, data on labor compensation (in millions of national currency) and total hours worked are decomposed based on skill level of the labor into three broad groups: low-, medium- and high-skill. Labor skill types are classified on the basis of educational attainment levels as defined in the International Standard Classification of Education (ISCED): low-skilled (ISCED categories 1 and 2), medium-skilled (ISCED 3 and 4) and high-skilled (ISCED 5 and 6). This decomposition, however, is absent in SEA 2016.

- **Capital**: Data on the current cost replacement value of the capital stock (in millions of national currency) and nominal gross fixed capital formation (in millions of national currency) along with the volume and price index of the latter is used to calculate capital deepening and misallocation of capital across countries and industries. For the 2013 vintage gross fixed capital formation

[4] International Labour Organization (2020).

and its associated volume index are used to calculate the implicit capital price deflator which is then used to construct a volume index for the real capital stock. For the 2016 vintage, the current cost replacement value of the capital stock by country-industry is deflated by a constructed capital price deflator. For country-industry combinations for which these deflators are available in OECD (2017), these deflators are taken from the STAN database for the industry at the lowest level of aggregation that contains the industry in our data. For country-industry combinations for which the capital price deflator is not available in STAN, we use the implicit capital price deflator from the closest corresponding industry in the 2013 vintage and then extrapolate it assuming a constant growth rate for the years 2008-2014.

- **Profits**: Profits are calculated as value added minus compensation minus capital service flows. The latter are calculated assuming an external rate of return equal to the U.S. corporate 10-yr BBB rate. We use the exchange rate to express the capital price deflator in each country in U.S. dollars. This allows us to calculate the capital price inflation in U.S. dollars, i.e. $\pi^K_{USD}$. Capital service flows for each country-industry combination are then calculated as

$$\left(i_{BBB} - \pi^K_{USD} + \delta_i\right) P^K_i K_i \tag{18}$$

Here, $i_{BBB}$ is the nominal BBB 10-yr corporate bond rate and $\delta_i$ is the average capital depreciation rate implied by the 2013 vintage capital data. In addition, $P^K_i K_i$ is the nominal replacement value of the capital stock. For the empirical implementation we have smoothed out fluctuations in $\pi^K_{USD}$ by using the average over vintage sample.

#### 4.2.3 Construction of capital deflators for 2016 vintage

A major source of discrepancies between the 2013 and 2016 vintages is differences in the nominal replacement value of the capital stocks. For the 2013 vintage, when available, they are taken from EU and US KLEMS data. For the 2016 vintage, when available, they are taken from the OECD STAN database. Other values are imputed. However, even those that are taken from these two data sources seem to be very different.

We have merged the the capital deflators from STAN into our data for the 2016 vintage. They are consistent with the nominal replacement values used and, for the countries for which we can obtain them, make our growth rate of the capital stock consistent with OECD STAN. For the other countries, we extrapolated the capital deflators from the 2013 vintage for the years we have missing data.

Depreciation rates are calculated by industry for the 2013 and applied to both the 2013 and 2016 vintages of the data.

#### 4.2.4 Construction of PPP-deflated value-added

In this section, we explain in more detail how we constructed a measure of PPP-deflated value added by double-deflating the benchmark PPP relative prices constructed by Timmer *et al.* (2007) and Inklaar & Timmer (2014).

**PPP benchmark prices**

The PPP benchmark tables report relative prices of industry gross output for industries and countries in the dataset. The numeraire good is US GDP in 2005, i.e. the relative price of US GDP in the benchmark table is 1. This means the relative price reported, $\mathcal{P}_{i,t}$, is the number of U.S. dollars in 2005 per unit of output in country-industry $i$ in 2005 relative to the number of U.S. dollars in 2005 per unit of U.S. GDP.

It is useful to consider this in mathematical form

$$\mathcal{P}_{i,t} = \frac{\$/GO_{i,t}}{\$/USGDP_t} = \frac{USGDP_t}{GO_{i,t}} \text{ for } t = 2005. \tag{19}$$

The first step is to calculate a time series for $\mathcal{P}_{i,t}$ for $t \neq 2005$. This can be done by using the time series for the price index for gross output in country-industry $i$ in year $t$, i.e. $P_{i,t}$, as well as the U.S. GDP deflator, $\mathcal{P}_t$.

Using these two time series, we can construct

$$\mathcal{P}_{i,t} = \mathcal{P}_{i,2005} \frac{P_{i,t}/P_{i,2005}}{\mathcal{P}_t/\mathcal{P}_{2005}}. \tag{20}$$

This gives us a time series of PPP conversion rates of the real gross output values into U.S. GDP.

**Dollars to PPP, denominated in US GDP**

The conversion factor derived above then allows us to convert nominal gross output in country-industry $i$ in year $t$, i.e. $P_{i,t}Y_{i,t}$, into units of U.S. GDP. Let $Y^*_{i,t}$ be output in country-industry $i$ in year $t$ measured in PPP units of U.S. GDP in the same period, then we can calculate it through

$$Y^*_{i,t} = \frac{P_{i,t}Y_{i,t}}{\mathcal{P}_{i,t}} \frac{1}{\mathcal{P}_t} = \frac{P_{i,t}Y_{i,t}}{P^*_{i,t}}, \text{ where } P^*_{i,t} = \mathcal{P}_{i,t}\mathcal{P}_t. \tag{21}$$

This equation means the following. The inverse of $\mathcal{P}_{i,t}$ converts dollars of nominal gross output of country-industry $i$ in year $t$ into dollars of nominal U.S. GDP in year $t$ according to the PPP adjustment. Dividing these dollars by the U.S. GDP deflator then gives the quantity of U.S. GDP produced in the sector.

Now, this allows us to calculate PPP adjusted *gross output*. However, what we really want to calculate is PPP adjusted *value added*. To obtain this, we need to do an additional calculation.

**Value added in terms of PPP**

To PPP adjust value added, we basically PPP adjust the nominal gross output and intermediate inputs terms in the definition of value added. That is, nominal value added of country-industry $i$ in year $t$ is the difference between nominal gross output and the nominal value of intermediate inputs.

$$P_{i,t}^{V} V_{i,t} = P_{i,t} Y_{i,t} - \sum_{i'} P_{i',t} M_{i',t}. \tag{22}$$

Now PPP adjusted value added of sector $i$ during year $t$, i.e. $V_{i,t}^{*}$, is obtained by PPP adjusting each of the individual nominal components. That is,

$$V_{i,t}^{*} = \frac{P_{i,t} Y_{i,t}}{P_{i,t}^{*}} - \sum_{i'} \frac{P_{i',t} M_{i',j',t}}{P_{i',t}^{*}}. \tag{23}$$

The implicit PPP deflator of value added of sector $i$ in year $t$ is then given by

$$P_{i,t}^{V*} = \frac{P_{i,t}^{V} V_{i,t}}{V_{i,t}^{*}}. \tag{24}$$

The calculation of (23) involves figuring out the intermediate inputs from all over the world using the WIOT and this requires using the input-output tables.

The other problem is that we cannot PPP adjust all intermediate inputs. One way of dealing with it is to use the same PPP deflator for the intermediate inputs for which we have no data compared to those for which we have data. The PPP deflator of the intermediate inputs that are covered is calculated using

$$P_{i,t}^{M*} = \sum_{i'} \frac{P_{i',t} M_{i',t}}{\sum_{i''} P_{i'',t} M_{i'',t}} P_{i',t}^{*}. \tag{25}$$

where $i'$ and $j'$ cover the intermediate inputs for which PPP adjusted deflators are measured. We then use this to deflate all the nominal intermediate inputs.

So, practically, we calculate $P^{M*}_{i,t}$ for each sector $i$ and year $t$ for all the intermediate inputs for which we have PPP adjusted gross output deflators. We then deflate *all* nominal intermediate inputs by this deflator to calculate PPP adjusted value added. We then calculate the implied PPP adjusted value-added deflator, (24).

This then allows us to calculate all the PPP adjusted data that we need for our analysis.

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Table 1: Dollar-denominated value-added shares, by country/region: 1996-2014

| SEA vintage | 2013 | | | | 2016 | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Country/region | 1996 - 2000 | 2001 - 2004 | 2005 - 2007 | All | 2001 - 2004 | 2005 - 2007 | 2008 - 2010 | 2011 - 2014 | All |
| United States | 0.33 | 0.37 | 0.33 | 0.34 | 0.37 | 0.33 | 0.29 | 0.27 | 0.32 |
| Great Britain | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.06 | 0.05 | 0.04 | 0.05 |
| Japan | 0.17 | 0.14 | 0.11 | 0.15 | 0.13 | 0.10 | 0.09 | 0.08 | 0.10 |
| Euro Area | 0.24 | 0.22 | 0.24 | 0.23 | 0.23 | 0.24 | 0.24 | 0.20 | 0.23 |
| Other advanced | 0.09 | 0.09 | 0.10 | 0.09 | 0.1 | 0.11 | 0.11 | 0.12 | 0.11 |
| Brazil | 0.03 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.03 | 0.04 | 0.03 |
| China | 0.04 | 0.05 | 0.06 | 0.05 | 0.05 | 0.06 | 0.10 | 0.14 | 0.09 |
| India | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.03 | 0.03 | 0.02 |
| Russia | 0.01 | 0.01 | 0.02 | 0.01 | 0.01 | 0.02 | 0.02 | 0.03 | 0.02 |
| Other emerging | 0.03 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.05 | 0.04 |
| Total | 1.00 | 1.00 | 1.00 | 1.00 | 1.0 | 1.00 | 1.00 | 1.00 | 1.00 |

Reported are contributions by country/region in percentage points over various subperiods.

Table 2: PPP-denominated value-added shares, by country/region: 1996-2014

| SEA vintage | 2013 | | | | 2016 | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Country/region | 1996 - 2000 | 2001 - 2004 | 2005 - 2007 | All | 2001 - 2004 | 2005 - 2007 | 2008 - 2010 | 2011 - 2014 | All |
| United States | 0.27 | 0.26 | 0.25 | 0.26 | 0.27 | 0.25 | 0.23 | 0.21 | 0.24 |
| Great Britain | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 |
| Japan | 0.10 | 0.09 | 0.08 | 0.09 | 0.08 | 0.08 | 0.07 | 0.06 | 0.07 |
| Euro Area | 0.22 | 0.21 | 0.19 | 0.21 | 0.22 | 0.20 | 0.18 | 0.16 | 0.19 |
| Other advanced | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 | 0.08 | 0.08 | 0.08 | 0.08 |
| Brazil | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 |
| China | 0.11 | 0.14 | 0.17 | 0.13 | 0.14 | 0.17 | 0.21 | 0.25 | 0.19 |
| India | 0.05 | 0.06 | 0.06 | 0.06 | 0.05 | 0.06 | 0.07 | 0.08 | 0.06 |
| Russia | 0.03 | 0.03 | 0.04 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 |
| Other emerging | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 |
| Total | 1.00 | 1.00 | 1.00 | 1.00 | 1.01 | 1.00 | 1.00 | 1.00 | 1.00 |

Reported are contributions by country/region in percentage points over various subperiods.

Table 3: Dollar-denominated value-added shares, by industry: 1996-2014

| SEA vintage | 2013 | | | | 2016 | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Country/region | 1996 - 2000 | 2001 - 2004 | 2005 - 2007 | All | 2001 - 2004 | 2005 - 2007 | 2008 - 2010 | 2011 - 2014 | All |
| Agriculture | 0.05 | 0.04 | 0.05 | 0.05 | 0.04 | 0.05 | 0.06 | 0.07 | 0.06 |
| Construction | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 |
| Nondurables manuf | 0.13 | 0.12 | 0.12 | 0.12 | 0.11 | 0.11 | 0.11 | 0.11 | 0.11 |
| Durables manuf | 0.06 | 0.06 | 0.06 | 0.06 | 0.07 | 0.07 | 0.06 | 0.07 | 0.07 |
| Trade Trans Utilities | 0.20 | 0.20 | 0.19 | 0.20 | 0.19 | 0.19 | 0.19 | 0.19 | 0.19 |
| FIRE | 0.16 | 0.17 | 0.17 | 0.17 | 0.16 | 0.16 | 0.16 | 0.16 | 0.16 |
| Business services | 0.09 | 0.10 | 0.10 | 0.10 | 0.14 | 0.14 | 0.14 | 0.13 | 0.14 |
| Education Healthcare | 0.08 | 0.08 | 0.09 | 0.08 | 0.08 | 0.08 | 0.09 | 0.08 | 0.08 |
| Hospitality | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.02 | 0.03 |
| Personal services | 0.04 | 0.04 | 0.04 | 0.04 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 |
| Government | 0.08 | 0.08 | 0.08 | 0.08 | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 |
| Households | 0.00 | 0.00 | 0.00 | 0.00 | 0.0 | 0.00 | 0.00 | 0.00 | 0.00 |
| Total | 1.00 | 1.00 | 1.00 | 1.00 | 1.0 | 1.00 | 1.00 | 1.00 | 1.00 |

Reported are contributions by industry in percentage points over various subperiods.

Table 4: PPP-denominated value-added shares, by industry: 1996-2014

| SEA vintage | 2013 | | | | 2016 | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Country/region | 1996 - 2000 | 2001 - 2004 | 2005 - 2007 | All | 2001 - 2004 | 2005 - 2007 | 2008 - 2010 | 2011 - 2014 | All |
| Agriculture | 0.09 | 0.08 | 0.07 | 0.08 | 0.08 | 0.07 | 0.07 | 0.07 | 0.07 |
| Construction | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 |
| Nondurables manuf | 0.16 | 0.15 | 0.15 | 0.15 | 0.14 | 0.14 | 0.14 | 0.15 | 0.15 |
| Durables manuf | 0.06 | 0.06 | 0.07 | 0.06 | 0.07 | 0.08 | 0.08 | 0.09 | 0.08 |
| Trade Trans Utilities | 0.18 | 0.19 | 0.19 | 0.19 | 0.19 | 0.20 | 0.19 | 0.18 | 0.19 |
| FIRE | 0.15 | 0.15 | 0.15 | 0.15 | 0.14 | 0.14 | 0.14 | 0.14 | 0.14 |
| Business services | 0.08 | 0.09 | 0.09 | 0.08 | 0.12 | 0.12 | 0.12 | 0.12 | 0.12 |
| Education Healthcare | 0.08 | 0.08 | 0.08 | 0.08 | 0.07 | 0.07 | 0.07 | 0.07 | 0.07 |
| Hospitality | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.02 | 0.02 | 0.02 |
| Personal services | 0.04 | 0.03 | 0.03 | 0.04 | 0.03 | 0.02 | 0.02 | 0.02 | 0.02 |
| Government | 0.06 | 0.06 | 0.06 | 0.06 | 0.07 | 0.07 | 0.07 | 0.07 | 0.07 |
| Households | 0.00 | 0.00 | 0.00 | 0.00 | 0.0 | 0.00 | 0.00 | 0.00 | 0.00 |
| Total | 1.00 | 1.00 | 1.00 | 1.00 | 1.01 | 1.00 | 1.00 | 1.00 | 1.00 |

Reported are contributions by industry in percentage points over various subperiods.

Table 5: Profits as a percentage of world GDP, by industry: 1996-2014

| SEA vintage | 2013 | | | | 2016 | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Country/region | 1996 - 2000 | 2001 - 2004 | 2005 - 2007 | All | 2001 - 2004 | 2005 - 2007 | 2008 - 2010 | 2011 - 2014 | All |
| Agriculture | 0.63 | 0.85 | 1.40 | 1.06 | 1.2 | 1.86 | 1.86 | 2.49 | 2.02 |
| Construction | 0.55 | 0.71 | 1.02 | 0.82 | 0.67 | 0.99 | 0.84 | 1.04 | 0.97 |
| Nondurables manuf | 1.83 | 2.17 | 3.02 | 2.72 | 2.49 | 2.98 | 2.47 | 2.80 | 3.06 |
| Durables manuf | 0.49 | 0.35 | 0.74 | 0.67 | 0.68 | 1.05 | 0.63 | 0.70 | 0.95 |
| Trade Trans Utilities | 2.33 | 3.01 | 4.01 | 3.58 | 3.82 | 4.50 | 3.91 | 4.86 | 4.88 |
| FIRE | -2.10 | 1.23 | 3.65 | 1.47 | 4.49 | 5.46 | 4.52 | 6.96 | 6.27 |
| Business services | 0.73 | 0.79 | 1.19 | 1.08 | 1.57 | 1.79 | 1.44 | 1.57 | 1.97 |
| Education Healthcare | 0.00 | 0.00 | 0.00 | 0.00 | 0.0 | 0.00 | 0.00 | 0.00 | 0.00 |
| Hospitality | 0.39 | 0.49 | 0.55 | 0.52 | 0.59 | 0.63 | 0.48 | 0.48 | 0.61 |
| Personal services | 0.00 | 0.00 | 0.00 | 0.00 | 0.0 | 0.00 | 0.00 | 0.00 | 0.00 |
| Government | 0.00 | 0.00 | 0.00 | 0.00 | 0.0 | 0.00 | 0.00 | 0.00 | 0.00 |
| Households | -0.00 | -0.00 | -0.00 | -0.00 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Total | 4.96 | 9.72 | 15.96 | 12.25 | 15.53 | 19.24 | 16.16 | 20.92 | 20.74 |

Reported are contributions by industry in percentage points over various subperiods.
Profits in Education/Healthcare, Personal care, Government, and Households are set to zero by construction.

Table 6: Contribution of country-industry specific TFP growth, by country/region: 1996-2014

| SEA vintage | 2013 | | | | 2016 | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Country/region | 1996 - 2000 | 2001 - 2004 | 2005 - 2007 | All | 2001 - 2004 | 2005 - 2007 | 2008 - 2010 | 2011 - 2014 | All |
| United States | 0.22 | 0.51 | -0.02 | 0.26 | 0.16 | 0.00 | 0.06 | -0.02 | 0.05 |
| Great Britain | 0.03 | 0.06 | 0.05 | 0.04 | 0.09 | 0.04 | -0.00 | 0.01 | 0.04 |
| Japan | 0.06 | 0.12 | 0.17 | 0.10 | -0.03 | 0.18 | -0.18 | 0.10 | 0.02 |
| Euro Area | 0.18 | 0.07 | 0.18 | 0.15 | 0.05 | 0.14 | -0.25 | 0.05 | 0.00 |
| Other advanced | 0.15 | 0.06 | 0.09 | 0.11 | 0.03 | 0.01 | -0.07 | -0.03 | -0.01 |
| Brazil | 0.01 | -0.00 | -0.02 | -0.00 | -0.0 | -0.04 | -0.02 | -0.14 | -0.05 |
| China | 0.21 | 0.29 | 0.56 | 0.33 | 0.15 | 0.45 | 0.24 | 0.29 | 0.27 |
| India | 0.03 | 0.01 | 0.08 | 0.04 | 0.01 | 0.05 | 0.02 | -0.13 | -0.02 |
| Russia | -0.03 | 0.03 | 0.06 | 0.02 | 0.04 | 0.06 | 0.04 | 0.03 | 0.04 |
| Other emerging | 0.04 | 0.02 | 0.12 | 0.05 | -0.04 | 0.08 | -0.01 | 0.04 | 0.02 |
| Total | 0.91 | 1.18 | 1.28 | 1.09 | 0.46 | 0.96 | -0.16 | 0.21 | 0.36 |

Reported are contributions by country/region to line 10 in Table 2 in percentage points over various subperiods. Results without markups.

Table 7: Contribution of markups to world GDP growth, by country/region: 1996-2014

| SEA vintage | 2013 | | | | 2016 | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Country/region | 1996 - 2000 | 2001 - 2004 | 2005 - 2007 | All | 2001 - 2004 | 2005 - 2007 | 2008 - 2010 | 2011 - 2014 | All |
| United States | 0.22 | 0.10 | 0.18 | 0.17 | 0.14 | 0.15 | -0.06 | 0.17 | 0.10 |
| Great Britain | 0.03 | 0.03 | 0.04 | 0.03 | 0.01 | 0.01 | 0.03 | -0.01 | 0.01 |
| Japan | -0.00 | -0.02 | -0.01 | -0.01 | -0.01 | -0.01 | -0.02 | -0.00 | -0.01 |
| Euro Area | 0.06 | 0.04 | 0.11 | 0.06 | 0.11 | 0.19 | -0.02 | 0.01 | 0.07 |
| Other advanced | 0.05 | 0.03 | 0.10 | 0.06 | 0.07 | 0.12 | 0.03 | 0.08 | 0.07 |
| Brazil | 0.01 | 0.00 | 0.02 | 0.01 | 0.01 | 0.04 | 0.04 | 0.03 | 0.03 |
| China | 0.04 | 0.10 | 0.31 | 0.13 | 0.08 | 0.14 | 0.19 | 0.14 | 0.14 |
| India | 0.02 | 0.02 | 0.05 | 0.03 | 0.03 | 0.05 | 0.05 | 0.05 | 0.04 |
| Russia | 0.00 | 0.03 | 0.06 | 0.02 | 0.03 | 0.07 | 0.03 | 0.04 | 0.04 |
| Other emerging | 0.08 | 0.04 | 0.09 | 0.07 | -0.01 | 0.10 | 0.02 | 0.08 | 0.05 |
| Total | 0.51 | 0.39 | 0.94 | 0.58 | 0.46 | 0.85 | 0.29 | 0.59 | 0.55 |

Reported are contributions by country/region to line 9 in Table 3 in percentage points over various subperiods.

Table 8: Contribution of markups to world GDP growth, by industry: 1996-2014

| SEA vintage | 2013 | | | | 2016 | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Country/region | 1996 - 2000 | 2001 - 2004 | 2005 - 2007 | All | 2001 - 2004 | 2005 - 2007 | 2008 - 2010 | 2011 - 2014 | All |
| Agriculture | 0.02 | 0.02 | 0.04 | 0.03 | 0.02 | 0.03 | 0.04 | 0.10 | 0.05 |
| Construction | 0.02 | 0.02 | 0.05 | 0.03 | 0.02 | 0.06 | 0.02 | 0.05 | 0.04 |
| Nondurables manuf | 0.08 | 0.07 | 0.19 | 0.10 | 0.05 | 0.14 | 0.04 | 0.09 | 0.08 |
| Durables manuf | 0.05 | 0.04 | 0.10 | 0.06 | 0.04 | 0.09 | 0.03 | 0.03 | 0.04 |
| Trade Trans Utilities | 0.16 | 0.15 | 0.23 | 0.17 | 0.13 | 0.22 | 0.07 | 0.15 | 0.14 |
| FIRE | 0.08 | 0.05 | 0.21 | 0.10 | 0.17 | 0.20 | 0.06 | 0.13 | 0.14 |
| Business services | 0.07 | 0.02 | 0.09 | 0.06 | 0.02 | 0.08 | 0.02 | 0.04 | 0.04 |
| Education Healthcare | 0.00 | 0.00 | 0.00 | 0.00 | 0.0 | 0.00 | 0.00 | 0.00 | 0.00 |
| Hospitality | 0.01 | 0.01 | 0.02 | 0.02 | 0.01 | 0.02 | 0.00 | 0.01 | 0.01 |
| Personal services | 0.00 | 0.00 | 0.00 | 0.00 | 0.0 | 0.00 | 0.00 | 0.00 | 0.00 |
| Government | 0.00 | 0.00 | 0.00 | 0.00 | 0.0 | 0.00 | 0.00 | 0.00 | 0.00 |
| Households | -0.00 | 0.00 | 0.00 | -0.00 | 0.0 | 0.00 | -0.00 | 0.00 | 0.00 |
| Total | 0.51 | 0.39 | 0.94 | 0.58 | 0.46 | 0.85 | 0.29 | 0.59 | 0.55 |

Reported are contributions by country/region to line 9 in Table 3 in percentage points over various subperiods.

Table 9: Summary of global PPP-TFP growth accounting *with* markups: 1996-2014

| SEA vintage | | | 2013 | | | | 2016 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| line | description | notation | 1996 - 2000 | 2001 - 2004 | 2005 - 2007 | All | 2001 - 2004 | 2005 - 2007 | 2008 - 2010 | 2011 - 2014 | All |
| 1) | World GDP growth | $\dot{v}$ | 5.42 | 5.37 | 8.05 | 6.06 | 5.11 | 7.94 | 3.29 | 5.57 | 5.46 |
| 2) | World capital growth | $s^K\dot{k}$ | 0.75 | 0.71 | 0.77 | 0.74 | 0.87 | 0.87 | 0.79 | 0.69 | 0.80 |
| 3) | World hours growth | $s^L\dot{l}$ | 0.75 | 1.39 | 0.21 | 0.83 | 0.65 | 0.43 | -0.03 | 1.82 | 0.79 |
| 4) | World TFP growth | $\dot{tfp}$ | 3.92 | 3.27 | 7.07 | 4.49 | 3.59 | 6.65 | 2.54 | 3.07 | 3.87 |
| 5) | Reallocation of capital | $\sum_i s_i^V s_i^K(\dot{k}_i - \dot{k})$ | 0.32 | 0.17 | 0.26 | 0.25 | 0.38 | 0.61 | 0.80 | 0.68 | 0.61 |
| 6) | ...within countries | | 0.20 | 0.07 | 0.15 | 0.15 | 0.08 | 0.16 | 0.04 | -0.00 | 0.07 |
| 7) | ...across countries | | 0.11 | 0.10 | 0.11 | 0.11 | 0.3 | 0.45 | 0.76 | 0.68 | 0.54 |
| 8) | Reallocation of hours | $\sum_i s_i^V s_i^L(\dot{l}_i - \dot{l})$ | 0.02 | -1.12 | 0.60 | -0.21 | -0.23 | 0.53 | -0.03 | -0.44 | -0.08 |
| 9) | ...within countries | | 0.08 | -0.19 | 0.36 | 0.06 | 0.15 | 0.34 | 0.25 | 0.27 | 0.25 |
| 10) | ...across countries | | -0.06 | -0.93 | 0.23 | -0.28 | -0.38 | 0.19 | -0.28 | -0.70 | -0.33 |
| 11) | Shifts in markups | $\sum_i s_i^D \frac{\mu_i}{1+\mu_i}\dot{y}_i$ | 0.60 | 0.60 | 1.46 | 0.81 | 0.69 | 1.18 | 0.55 | 0.77 | 0.79 |
| 12) | ...Shifts in average markups | $\frac{\bar{\mu}}{1+\bar{\mu}}\dot{\bar{y}}$ | 0.48 | 0.50 | 1.34 | 0.70 | 0.75 | 1.38 | 0.53 | 1.07 | 0.93 |
| 13) | ...Output shifts | $\sum_i s_i^D \frac{\mu_i}{1+\mu_i}(\dot{y}_i - \dot{\bar{y}})$ | 0.12 | 0.11 | 0.12 | 0.11 | -0.05 | -0.20 | 0.02 | -0.30 | -0.14 |
| 14) | Country-industry TFP growth | $\sum_i s_i^D \frac{1}{1+\mu_i}\dot{z}_i$ | 2.98 | 3.62 | 4.75 | 3.64 | 2.75 | 4.32 | 1.21 | 2.05 | 2.56 |

Lines in this table correspond to parts of equation (11). Reported are contributions to average annual growth rates in percentage points over various subperiods. Results with markups.

Table 10: Summary of Euro Area TFP growth accounting with markups: 1996-2014

| SEA vintage | | | 2013 | | | | 2016 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| line | description | notation | 1996 - 2000 | 2001 - 2004 | 2005 - 2007 | All | 2001 - 2004 | 2005 - 2007 | 2008 - 2010 | 2011 - 2014 | All |
| 1) | Euro Area GDP growth | $\dot{v}$ | 2.68 | 1.56 | 2.69 | 2.31 | 1.5 | 2.64 | -0.71 | 0.38 | 0.95 |
| 2) | Euro Area capital growth | $s^K \dot{k}$ | 0.74 | 0.72 | 0.68 | 0.72 | 0.41 | 0.49 | 0.35 | 0.12 | 0.33 |
| 3) | Euro Area hours growth | $s^L \dot{l}$ | 0.74 | 0.33 | 0.86 | 0.63 | 0.38 | 0.99 | -0.60 | -0.29 | 0.11 |
| 4) | Euro Area TFP growth | $t\dot{f}p$ | 1.21 | 0.52 | 1.16 | 0.97 | 0.71 | 1.16 | -0.46 | 0.55 | 0.51 |
| 5) | Reallocation of capital | $\sum_i s_i^V s_i^K (\dot{k}_i - \dot{k})$ | 0.15 | 0.07 | 0.06 | 0.10 | 0.07 | 0.09 | 0.06 | 0.01 | 0.05 |
| 6) | ...within countries | | 0.14 | 0.08 | 0.09 | 0.11 | 0.07 | 0.09 | 0.05 | 0.01 | 0.05 |
| 7) | ...across countries | | 0.01 | -0.02 | -0.03 | -0.01 | -0.0 | 0.00 | 0.01 | 0.00 | 0.00 |
| 8) | Reallocation of hours | $\sum_i s_i^V s_i^L (\dot{l}_i - \dot{l})$ | -0.04 | -0.11 | -0.09 | -0.08 | -0.13 | -0.11 | 0.15 | 0.10 | 0.00 |
| 9) | ...within countries | | 0.03 | 0.00 | 0.01 | 0.01 | -0.0 | -0.01 | 0.03 | -0.00 | 0.00 |
| 10) | ...across countries | | -0.07 | -0.11 | -0.11 | -0.09 | -0.12 | -0.10 | 0.12 | 0.10 | -0.00 |
| 11) | Shifts in markups | $\sum_i s_i^D \frac{\mu_i}{1+\mu_i} \dot{y}_i$ | 0.23 | 0.18 | 0.45 | 0.27 | 0.51 | 0.77 | -0.06 | 0.06 | 0.32 |
| 12) | ...Shifts in average markups | $\frac{\bar{\mu}}{1+\bar{\mu}} \dot{\bar{y}}$ | 0.18 | 0.10 | 0.37 | 0.20 | 0.4 | 0.75 | -0.19 | 0.02 | 0.24 |
| 13) | ...Output shifts | $\sum_i s_i^D \frac{\mu_i}{1+\mu_i} (\dot{y}_i - \dot{\bar{y}})$ | 0.06 | 0.08 | 0.08 | 0.07 | 0.12 | 0.02 | 0.14 | 0.03 | 0.08 |
| 14) | Country-industry TFP growth | $\sum_i s_i^D \frac{1}{1+\mu_i} \dot{z}_i$ | 0.87 | 0.38 | 0.74 | 0.68 | 0.26 | 0.40 | -0.61 | 0.38 | 0.14 |

Lines in this table correspond to parts of equation (11). Reported are contributions to average annual growth rates in percentage points over various subperiods.

Table 11: Summary of global ALP growth accounting: 1996-2014

| SEA vintage | | | 2013 | | | | 2016 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| line | description | notation | 1996 - 2000 | 2001 - 2004 | 2005 - 2007 | All | 2001 - 2004 | 2005 - 2007 | 2008 - 2010 | 2011 - 2014 | All |
| 1) | World GDP growth | $\dot{v}$ | 3.33 | 2.51 | 3.70 | 3.15 | 2.31 | 3.65 | 0.91 | 2.56 | 2.37 |
| 2) | World hours growth | $\dot{l}$ | 1.18 | 2.44 | 0.39 | 1.40 | 1.16 | 0.85 | -0.07 | 3.38 | 1.46 |
| 3) | World ALP growth | $\dot{alp}$ | 2.15 | 0.07 | 3.31 | 1.75 | 1.15 | 2.80 | 0.98 | -0.82 | 0.90 |
| 4) | Relative hours growth | $\sum_i s_i^V(\dot{l}_i - \dot{l})$ | 0.02 | -2.04 | 1.11 | -0.40 | -0.79 | 0.82 | -0.71 | -1.49 | -0.62 |
| 5) | ...Reallocation of hours | $\sum_i s_i^V s_i^L(\dot{l}_i - \dot{l})$ | -0.01 | -1.34 | 0.50 | -0.33 | -0.56 | 0.35 | -0.36 | -0.97 | -0.44 |
| 6) | ...within countries | | 0.07 | -0.02 | 0.15 | 0.06 | 0.03 | 0.08 | 0.08 | 0.09 | 0.07 |
| 7) | ...across countries | | -0.08 | -1.32 | 0.35 | -0.39 | -0.6 | 0.27 | -0.44 | -1.07 | -0.51 |
| 8) | Country-industry ALP growth | $\sum_i s_i^V \dot{alp}_i$ | 2.14 | 2.11 | 2.20 | 2.15 | 1.94 | 1.98 | 1.70 | 0.67 | 1.53 |

Lines in this table correspond to parts of equation (16). Reported are contributions to average annual growth rates in percentage points over various subperiods.

Table 12: Contribution of country-industry specific ALP growth, by country/region: 1996-2014

| SEA vintage | 2013 | | | | 2016 | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Country/region | 1996 - 2000 | 2001 - 2004 | 2005 - 2007 | All | 2001 - 2004 | 2005 - 2007 | 2008 - 2010 | 2011 - 2014 | All |
| United States | 0.75 | 1.01 | 0.42 | 0.76 | 0.92 | 0.38 | 0.54 | -0.00 | 0.46 |
| Great Britain | 0.11 | 0.13 | 0.10 | 0.11 | 0.13 | 0.05 | 0.03 | 0.01 | 0.06 |
| Japan | 0.31 | 0.25 | 0.19 | 0.26 | 0.27 | 0.12 | -0.08 | 0.06 | 0.11 |
| Euro Area | 0.33 | 0.23 | 0.30 | 0.29 | 0.21 | 0.23 | 0.04 | 0.16 | 0.16 |
| Other advanced | 0.27 | 0.16 | 0.20 | 0.21 | 0.13 | 0.14 | 0.04 | 0.07 | 0.10 |
| Brazil | 0.04 | -0.00 | 0.02 | 0.02 | -0.02 | -0.00 | 0.27 | -0.05 | 0.04 |
| China | 0.30 | 0.28 | 0.53 | 0.35 | 0.23 | 0.67 | 0.65 | 0.59 | 0.52 |
| India | 0.06 | 0.02 | 0.17 | 0.07 | 0.05 | 0.13 | 0.12 | -0.11 | 0.04 |
| Russia | -0.02 | 0.04 | 0.11 | 0.03 | 0.05 | 0.09 | 0.09 | 0.02 | 0.06 |
| Other emerging | -0.00 | -0.01 | 0.17 | 0.04 | -0.04 | 0.17 | -0.01 | -0.09 | -0.00 |
| Total | 2.14 | 2.11 | 2.20 | 2.15 | 1.94 | 1.98 | 1.70 | 0.67 | 1.53 |

Reported are contributions by country/region to line 8 in Table 11 in percentage points over various subperiods.

Table 13: List of countries in each vintage of SEA and the ones that have PPP data

| | Country | SEA 2013 | SEA 2016 | PPP |
|---|---|---|---|---|
| 1. | Australia | ✓ | ✓ | ✓ |
| 2. | Austria | ✓ | ✓ | ✓ |
| 3. | Belgium | ✓ | ✓ | ✓ |
| 4. | Bulgaria | ✓ | ✓ | ✓ |
| 5. | Brazil | ✓ | ✓ | ✓ |
| 6. | Canada | ✓ | ✓ | ✓ |
| 7. | Switzerland | | ✓ | |
| 8. | China | ✓ | ✓ | ✓ |
| 9. | Cyprus | ✓ | ✓ | ✓ |
| 10. | Czech Republic | ✓ | ✓ | ✓ |
| 11. | Germany | ✓ | ✓ | ✓ |
| 12. | Denmark | ✓ | ✓ | ✓ |
| 13. | Spain | ✓ | ✓ | ✓ |
| 14. | Estonia | ✓ | ✓ | ✓ |
| 15. | Finland | ✓ | ✓ | ✓ |
| 16. | France | ✓ | ✓ | ✓ |
| 17. | United Kingdom | ✓ | ✓ | ✓ |
| 18. | Greece | ✓ | ✓ | ✓ |
| 19. | Croatia | | ✓ | |
| 20. | Hungary | ✓ | ✓ | ✓ |
| 21. | Indonesia | ✓ | ✓ | ✓ |
| 22. | India | ✓ | ✓ | ✓ |
| 23. | Ireland | ✓ | ✓ | ✓ |
| 24. | Italy | ✓ | ✓ | ✓ |
| 25. | Japan | ✓ | ✓ | ✓ |
| 26. | South Korea | ✓ | ✓ | ✓ |
| 27. | Lithuania | ✓ | ✓ | ✓ |
| 28. | Luxembourg | ✓ | ✓ | ✓ |
| 29. | Latvia | ✓ | ✓ | ✓ |
| 30. | Mexico | ✓ | ✓ | ✓ |
| 31. | Malta | ✓ | ✓ | ✓ |
| 32. | Netherlands | ✓ | ✓ | ✓ |
| 33. | Norway | | ✓ | |
| 34. | Poland | ✓ | ✓ | ✓ |
| 35. | Portugal | ✓ | ✓ | ✓ |
| 36. | Romania | ✓ | ✓ | ✓ |
| 37. | Russia | ✓ | ✓ | ✓ |
| 38. | Slovakia | ✓ | ✓ | ✓ |
| 39. | Slovenia | ✓ | ✓ | ✓ |
| 40. | United States | ✓ | ✓ | ✓ |
| 41. | Turkey | ✓ | ✓ | ✓ |
| 42. | Taiwan | ✓ | ✓ | |
| 43. | United States | ✓ | ✓ | ✓ |

Table 14: Country Classification

| Region | Country |
|---|---|
| Euro Area | Germany, France, Austria, Italy, Belgium, Cyprus, Spain, Estonia, Finland, Greece, Ireland, Lithuania, Luxembourg, Latvia, Malta, Netherlands, Portugal, Slovakia, Slovenia |
| Other Advanced | Canada, South Korea, Taiwan, Australia, Switzerland, Denmark, Sweden, Norway, Bulgaria, Czech Republic, Croatia, Hungary, Poland, Romania |
| Other Emerging | Indonesia, Turkey, Mexico |

Table 15: Industry Classification

| Major sector | ISIC v3 industries included[1] |
|---|---|
| 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 | |

[1] For World Input-Output Database (WIOD) vintage 2016 ISIC v4 industries are aggregated to ISIC v3 using the crosswalk provided in the data documentation (Gouma *et al.*, 2018).

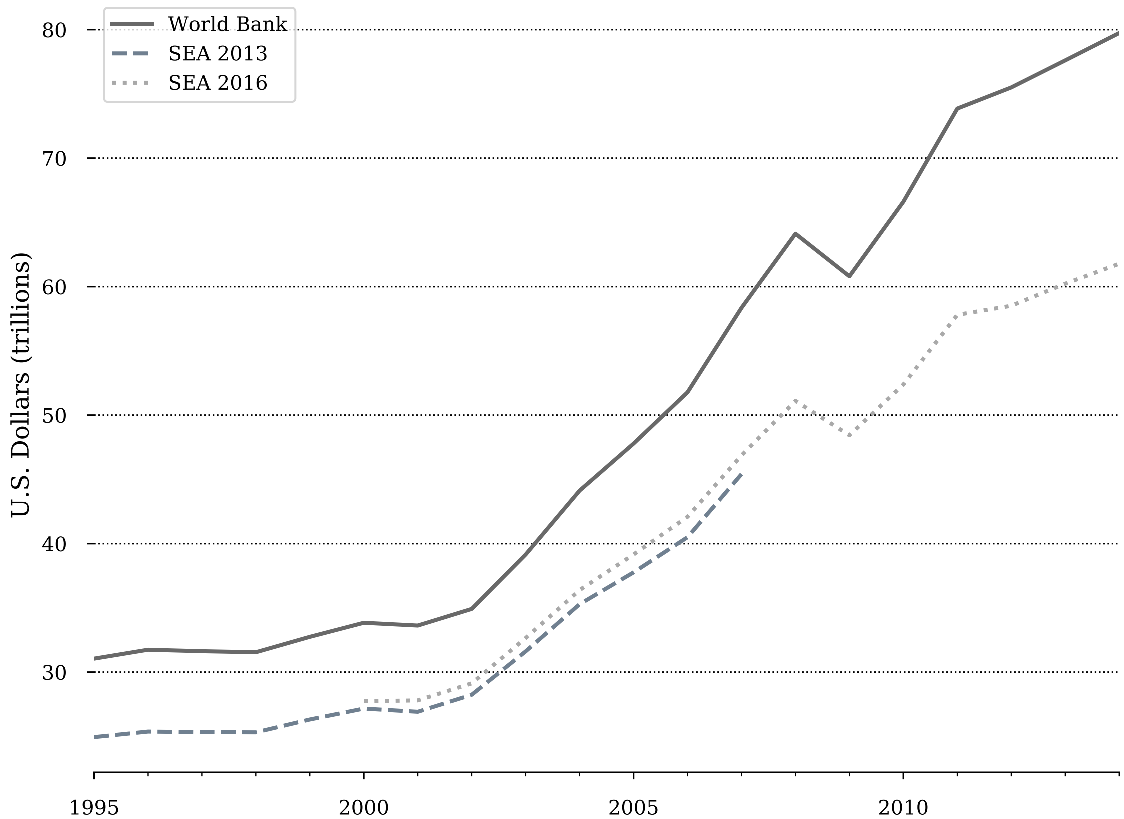


Figure 1: Nominal world GDP in WIOD-SEA and World Development Indicators (WDI)

Source: Timmer (2012) and World Bank (2018).

Note: SEA data is total nominal value added for all industries and countries in both vintages of the WIOD. All measures are reported in current U.S. $.

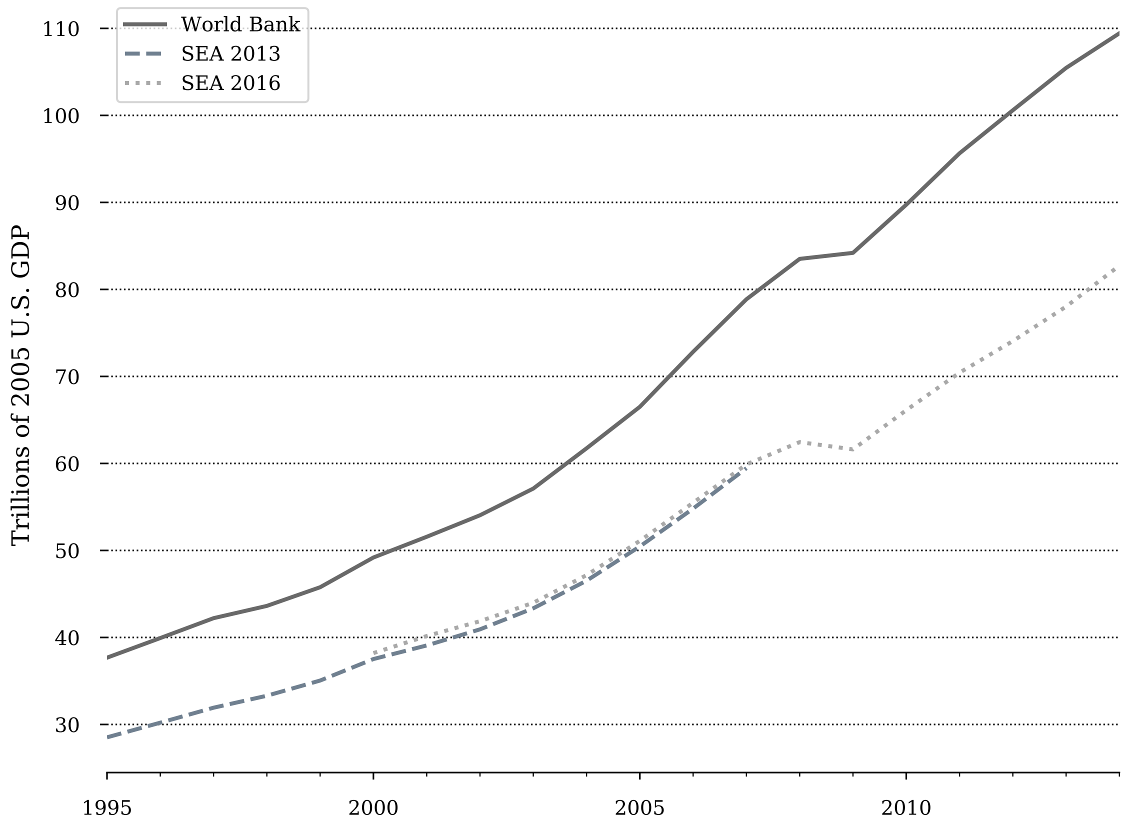


Figure 2: World GDP PPP in WIOD-SEA and WDI

Source: Timmer (2012), and World Bank (2018), and authors' calculations.

Note: SEA data is total value added PPP for all industries and countries in both vintages of the WIOD. All measures are reported in U.S. $ of 2005 U.S. GDP.


Figure 3: Growth in world GDP PPP in WIOD-SEA and WDI

Source: Timmer (2012), and World Bank (2018), and authors' calculations.
Note: World GDP PPP growth is constructed as real PPP-adjusted value-added share weighted average of nominal GDP or real country-industry value-added PPP growth.

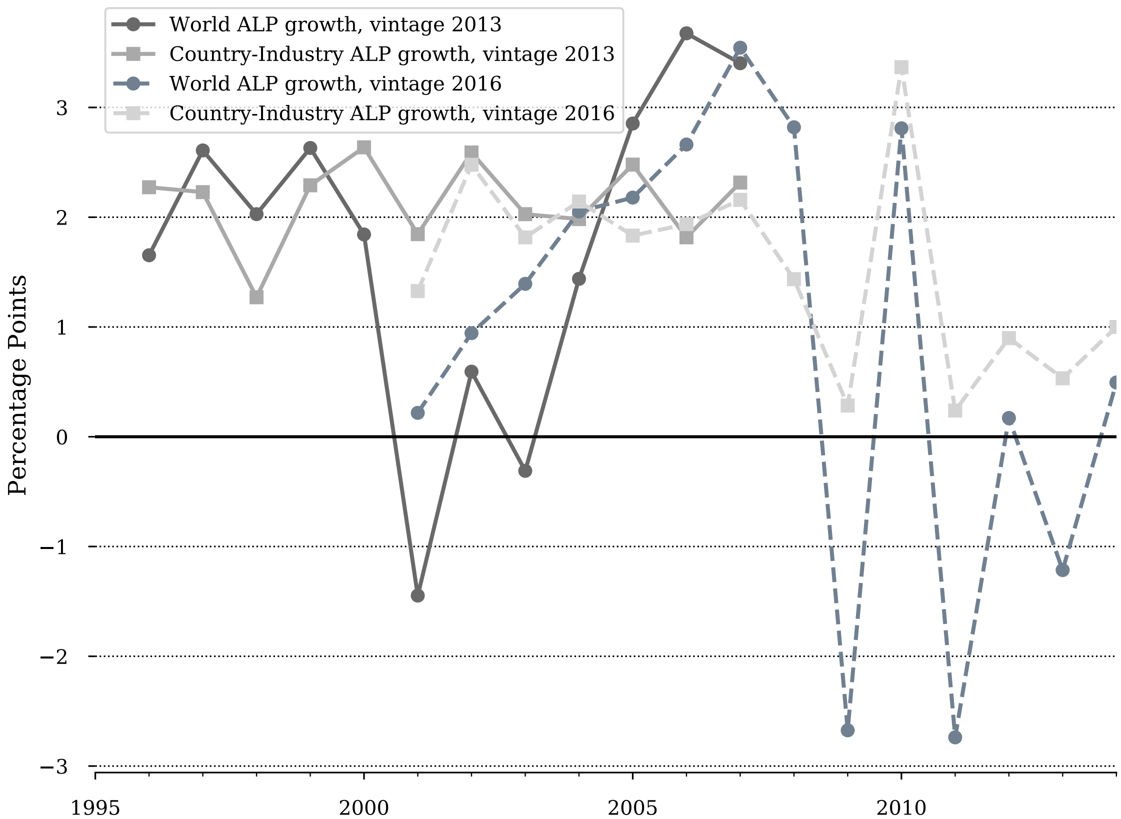


Figure 4: TFP growth: World vs. country-industry component, vintage 2016.
Note: Solid line is 2013 vintage and dashed line is 2016 vintage.
Source: Timmer (2012), OECD (2017), and authors' calculations.