Gone with the Headwinds: global productivity

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Brookings Institution,
May 15th 2017

* this presentation of IMF staff discussion note 17/04 and related papers reflects joint work with gustavo adler, Jaebin ahn, sinem Kilic celik, davide Furceri, gee hee hong, Ksenia Koloskova, marcos Poplawski-Ribeiro and Yannick timmer

The productivity slowdown debate

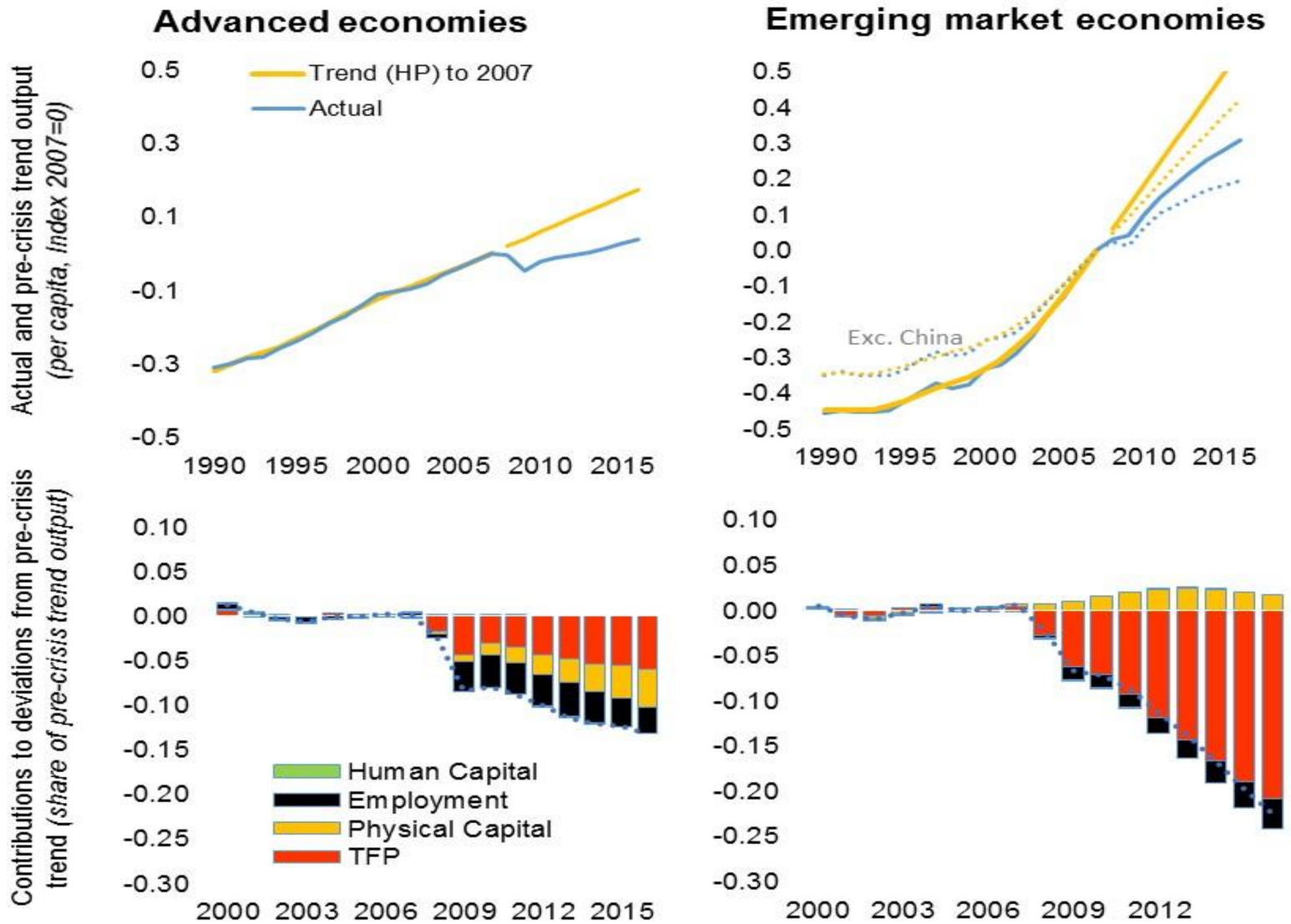
- Productivity slowdown in advanced economies:
  - Started around late 1960s
  - Small transitory reversal during 1990s followed by renewed slowdown since early 2000s
  - Further slowdown following the global financial crisis (GFC)

- Productivity slowdown debate in a nutshell:
  - Has innovation slowed? Temporary or permanent? (techno-pessimists vs. techno-optimists)
  - Has diffusion slowed? (Haltiwanger and co-authors, OECD)
  - If so why? Role of market structure (winner-takes-all dynamics), skills deficiencies and mismatches (Bloom, Sadun, and Van Reenen 2016), insufficient labor and product market reforms (Cette, Mojon, Fernald 2016)…in presence of disruptive ICT-related technological change

- What we bring to the debate:
  - Role of GFC itself: post-GFC slowdown too abrupt, large and persistent to reflect *only* slow-moving forces dragging on innovation or diffusion
  - Role of other secular forces slowing innovation and/or diffusion: aging, trade, human capital

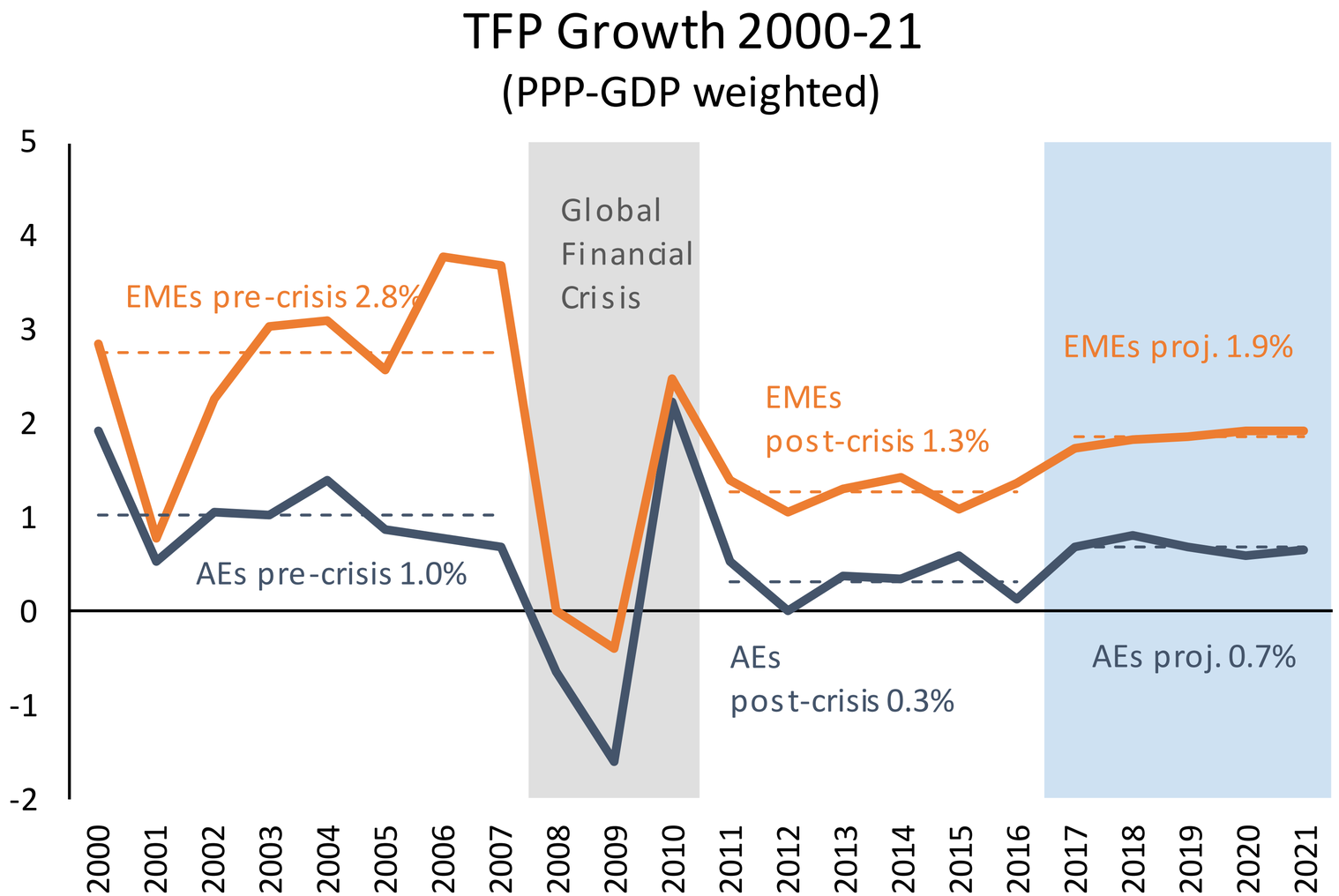
The productivity slowdown:
The short, medium and long-term views

TFP loss has been major contributor to post-GFC output loss…



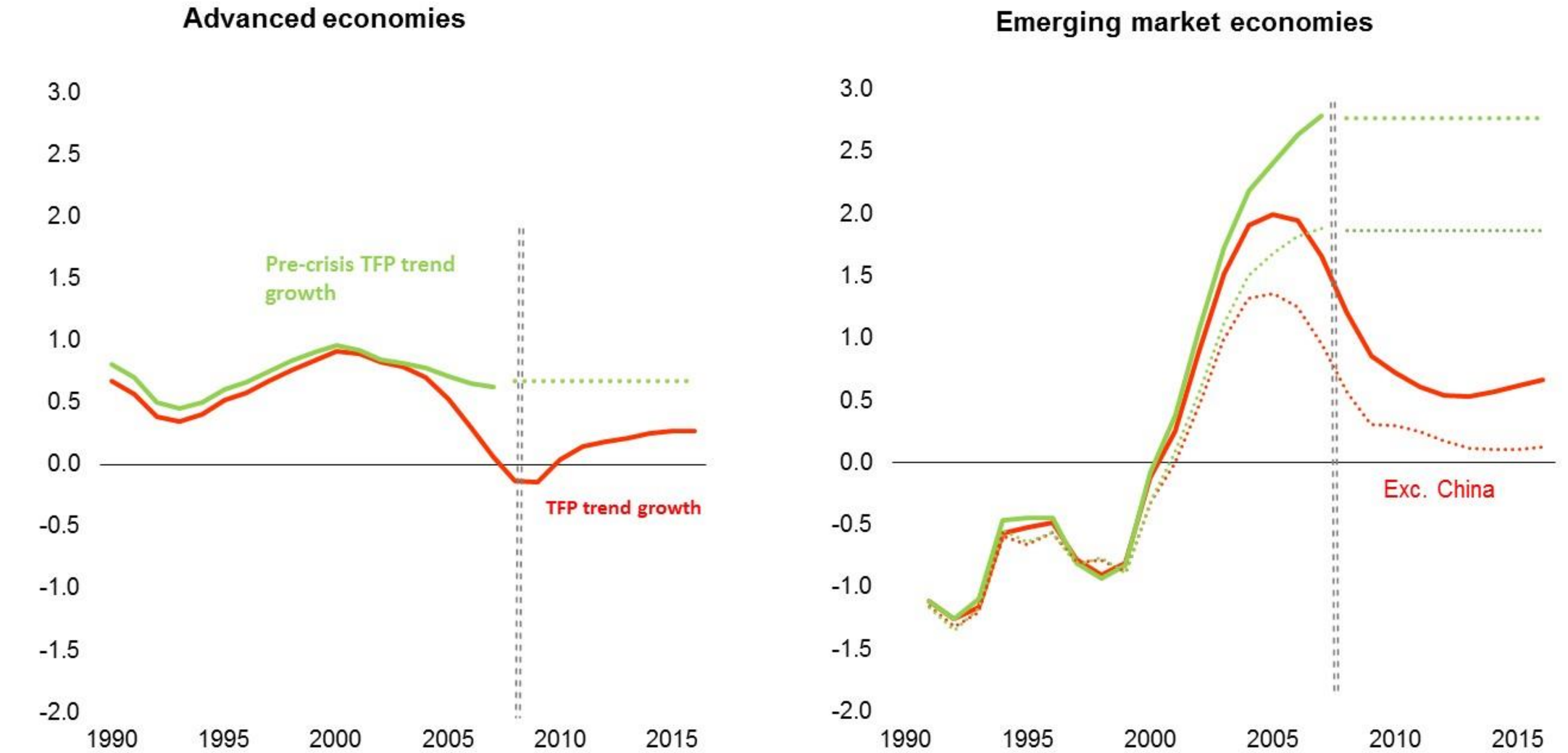
Sources: Sources: PWT 9.0; and IMF staff estimates and projections. Note: PPP-GDP weighted average by group, based on IMF WEO country classification.

…and the post-GFC TFP slowdown has been sharp and persistent…



Sources: Penn World Table 9.0; World Economic Outlook, and IMF staff calculations.
Weighted averages (using PPP-GDP as weights) are reported for each income group. For AE (EMEs), 20 (18) largest economies are reported.

…amplifying a slowdown that was under way before the GFC…

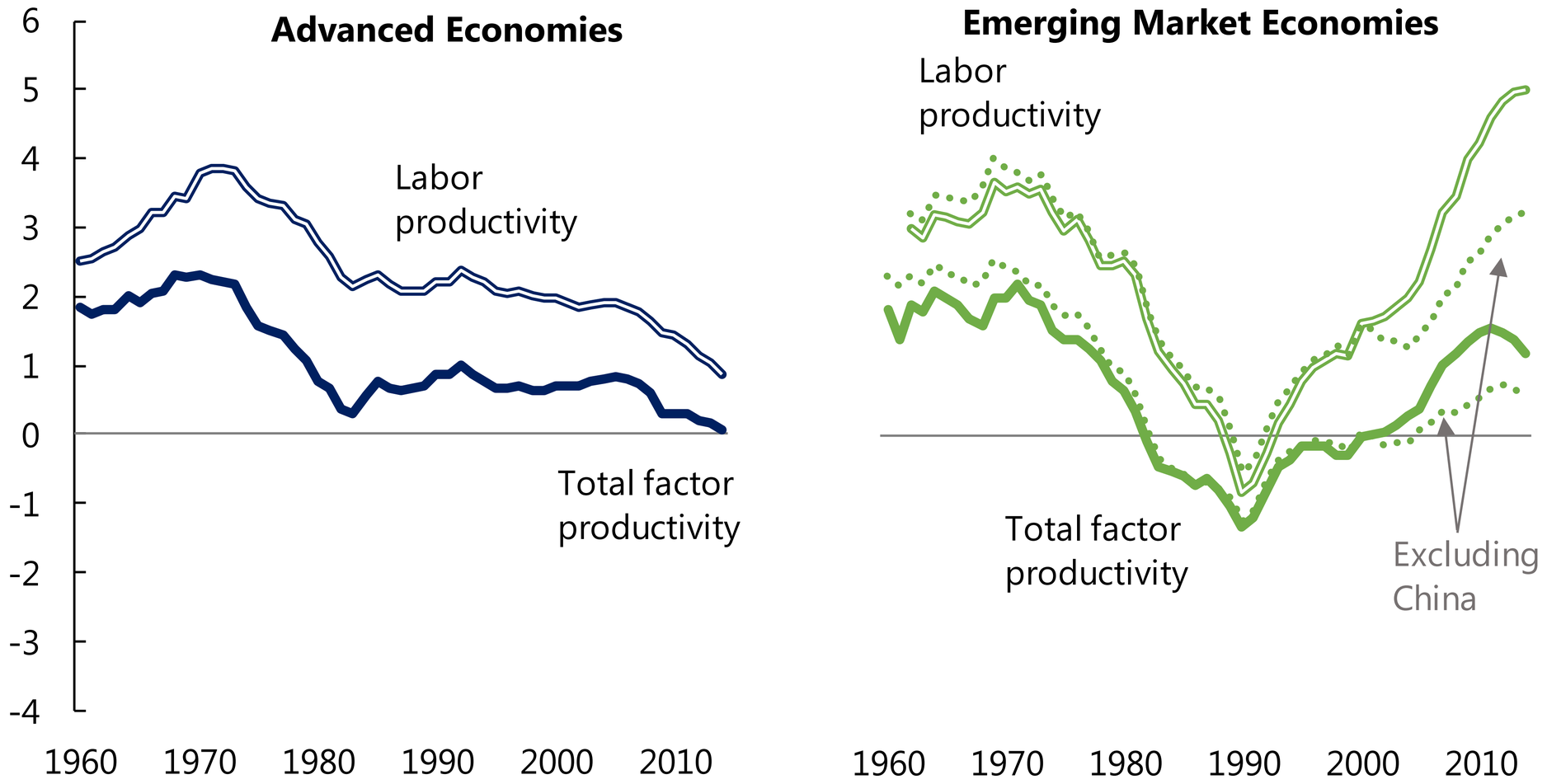


Sources: Sources: PWT 9.0; and IMF staff estimates and projections.
Note: HP filter trends computed up to 2007 and up to 2016. PPP-GDP weighted average by group, based on WEO country classification.

The two-stage slowdown in AEs since the early 2000s is substantial, although far less dramatic than in the 1970s

TFP Growth, 1950-2014

(percent, 10-year backward-looking moving average)



Sources: PWT 9.0; and IMF staff estimates and projections. Note: PPP-GDP weighted average by group, based on IMF WEO country classification

The post-GFC TFP slowdown: the role of GFC legacies

- "TFP hysteresis" from deep recessions

- At least three causes of hysteresis this time around:
- Balance sheet vulnerabilities
- Protracted weak demand and capital-embodied technological change
- Elevated economic and policy uncertainty

- Common feature: conducive to lower and low risk/low return investment (# intangibles, ICT… etc)

Past deep recessions have created "TFP hysteresis" and the GFC was no different

Estimate response of cyclically-adjusted TFP to major past recessions using local projection method (Jorda, 2005):

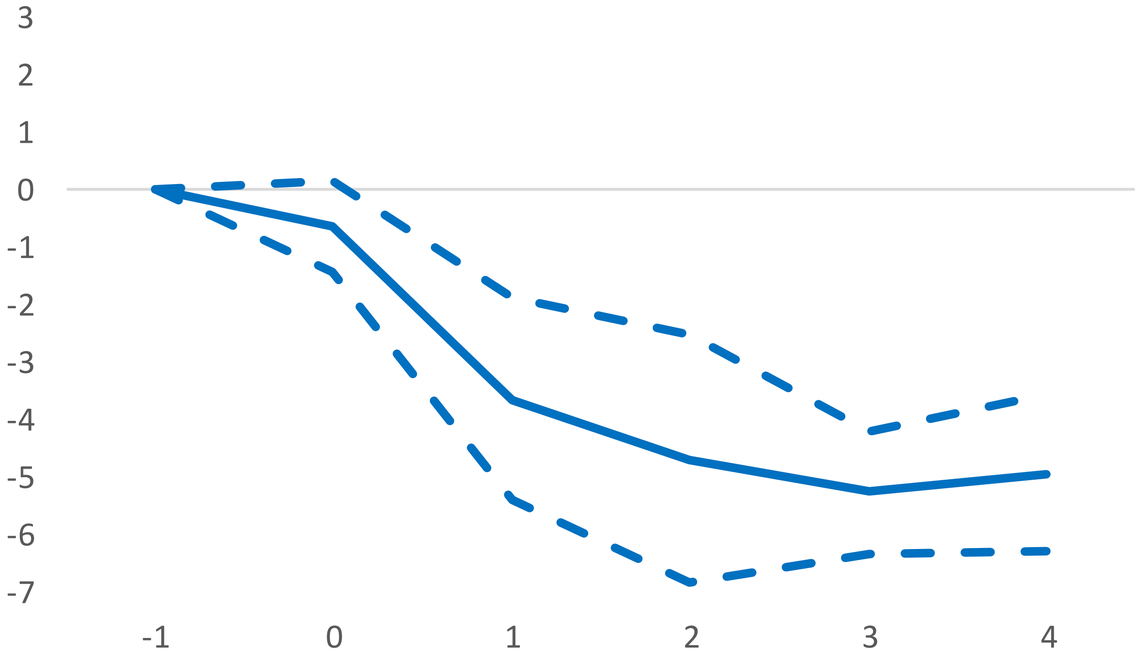
$$y_{i,t+k} - y_{i,t-1} = \alpha_j + \gamma_t + \sum_{s=1}^{2} \delta_s^k \Delta y_{i,t-s} + \beta_k D_{i,t} + \sum_{s=1}^{2} \theta_s^k D_{i,t-s} + \sum_{s=0}^{k-1} \rho_s^k D_{i,t+k-s} + \varepsilon_{i,t}$$

Where:

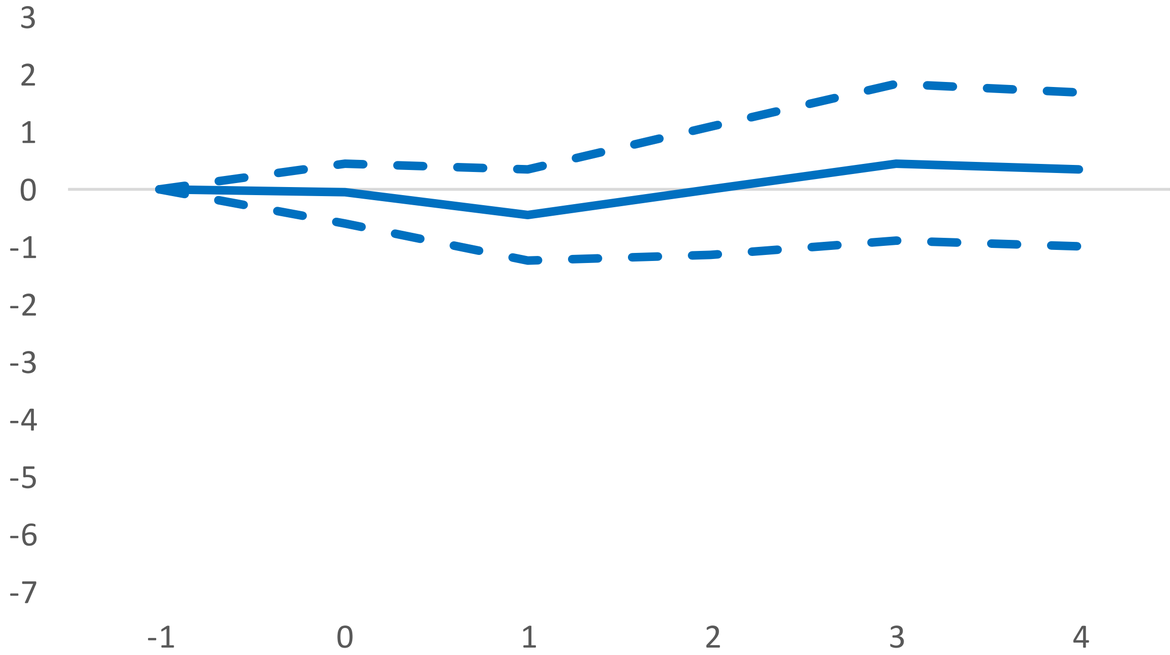
- $y_{i,t+k} - y_{i,t-1}$ is the cumulative change of variable of interest (output, TFP) for country i between t-1 and t+k
- α_j, γ_t are country and time fixed effects
- D is a dummy variable taking value 1 at the start of major recession
- Other controls include: i) past output growth (2 lags); ii) lagged recession dates (2 lags); iii) country-specific trends; iv) forward values of recession dummy between t and t+k-1 (bias correction proposed by Teulings and Zubanov 2014)

Past deep recessions have created “TFP hysteresis” and the GFC was no different

Average response of cyclically-adjusted TFP to past **deep recessions**



Average response of cyclically-adjusted TFP to past **regular recessions**

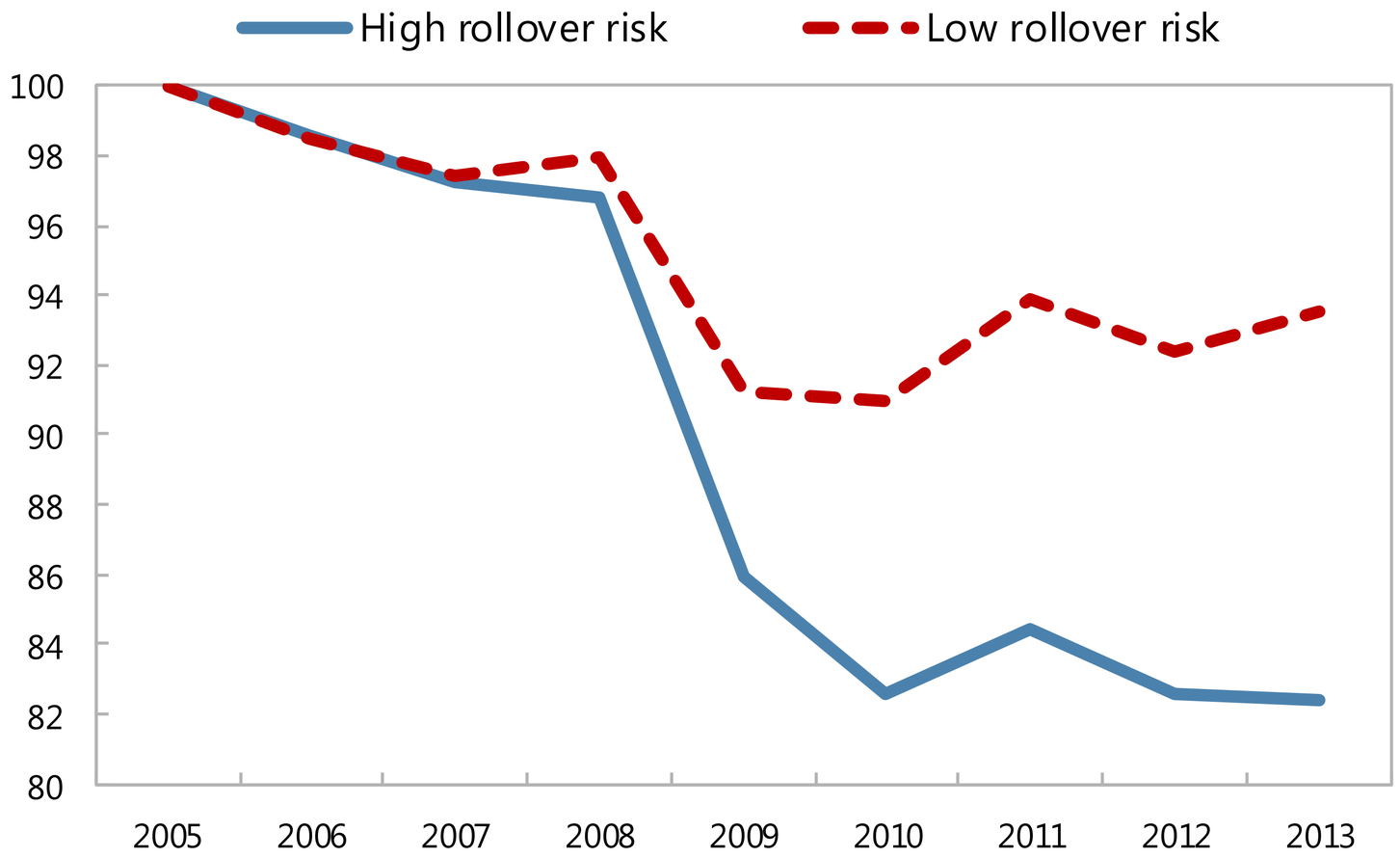


Sources: KLEMS; Blanchard, Cerutti, Summers (2015); IMF staff calculations. Note: The cyclically-adjusted measure of TFP based on Basu, Fernald and Kimball (2006) is used. Major recessions are the biggest 10% falls in GDP in the first two years of a recession episode across 17 advanced economies over 1970-2007. The response of cyclically-adjusted TFP to major past recessions is estimated using a local projections method (Jorda 2005), see Adler, Duval, Furceri, Koloskova and Poplawski-Ribeiro (2017) for details.

Crisis legacy No. 1. Balance sheet vulnerabilities

Observed TFP level path for low- and high-rollover risk firms

(index, 2005=100)



Sources: Duval, Timmer and Hong 2017, using Orbis data. Note: High/low rollover risk correspond to the 75th and 25th percentiles of the cross-country cross-firm distribution of rollover risk in the sample. Rollover risk is measured as debt maturing within a year in 2007, in percent of total sales.

Crisis legacy No. 1. Balance sheet vulnerabilities

Estimate on firm-level (Orbis) data:

$$\Delta TFP_{isc}^{growth} = \beta_1 Vulnerability_i^{pre} + \beta_2 Vulnerability_i^{pre} * \Delta \mathrm{CDS}_i + \gamma' \mathrm{X}_i + + \alpha_{sc} + \varepsilon_{isc}$$

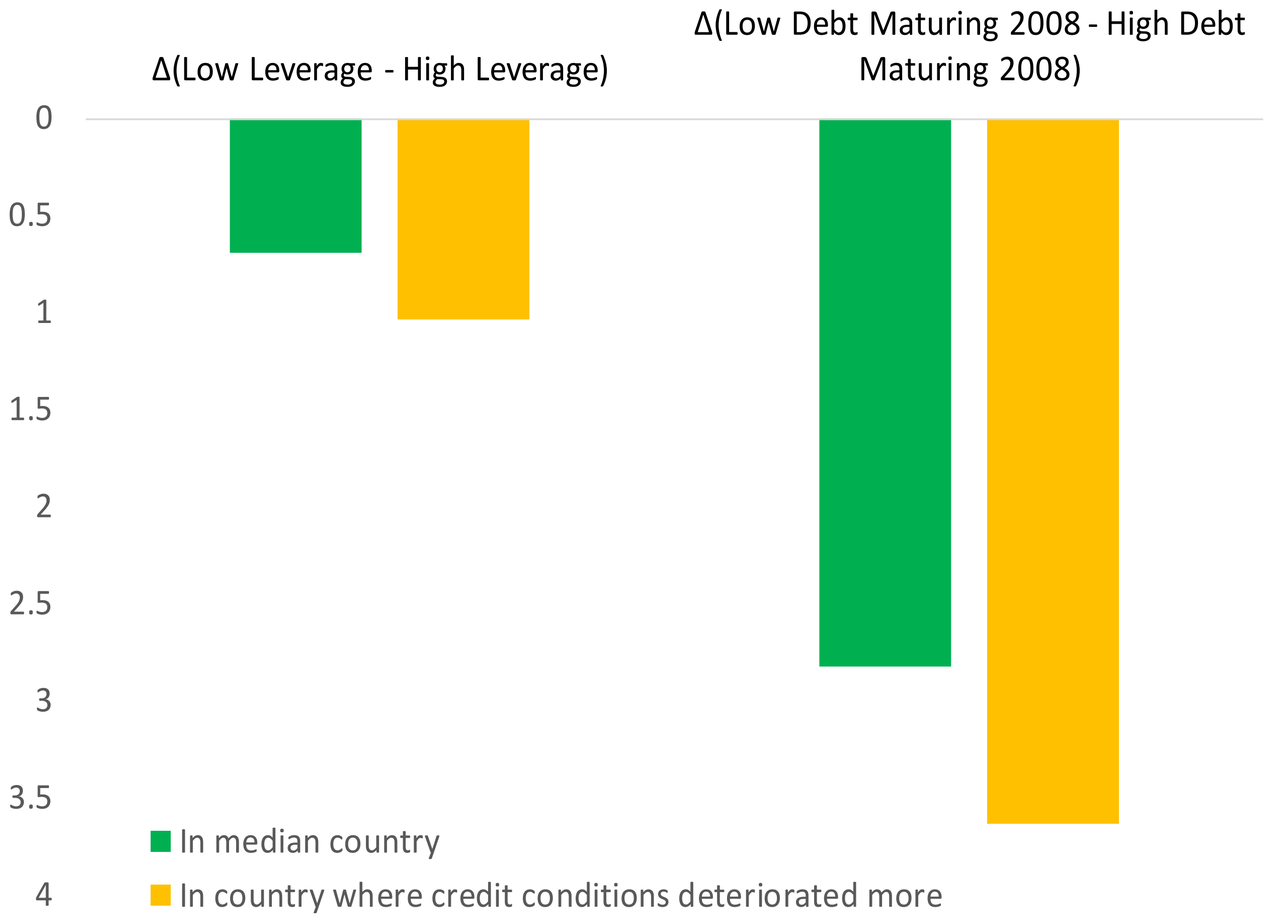
Where:

- $\Delta TFP_{isc}^{growth}$ is change in average TFP growth between 6 years before and after the GFC
- *Vulnerability*: i) debt maturing in 2008; ii) average pre-crisis leverage (total debt/assets)
- ΔCDS_i is change in average bank CDS spread in country i between 2008H1 and H2 (hypothesis: stressed banking systems tightened credit conditions more, amplifying adverse TFP impact of firm vulnerabilities)
- α_{sc} is country-sector FE ➔ *within* country-sector comparison between different firms
- X = controls: size, sales, EBITDA, employment

➔ Comparison post-event vs. pre-event (see e.g. Giroud and Mueller 2017; Mian and Sufi 2014)

Crisis legacy No. 1. Balance sheet vulnerabilities

Estimated Drop in TFP growth after the financial crisis *(percentage points)*



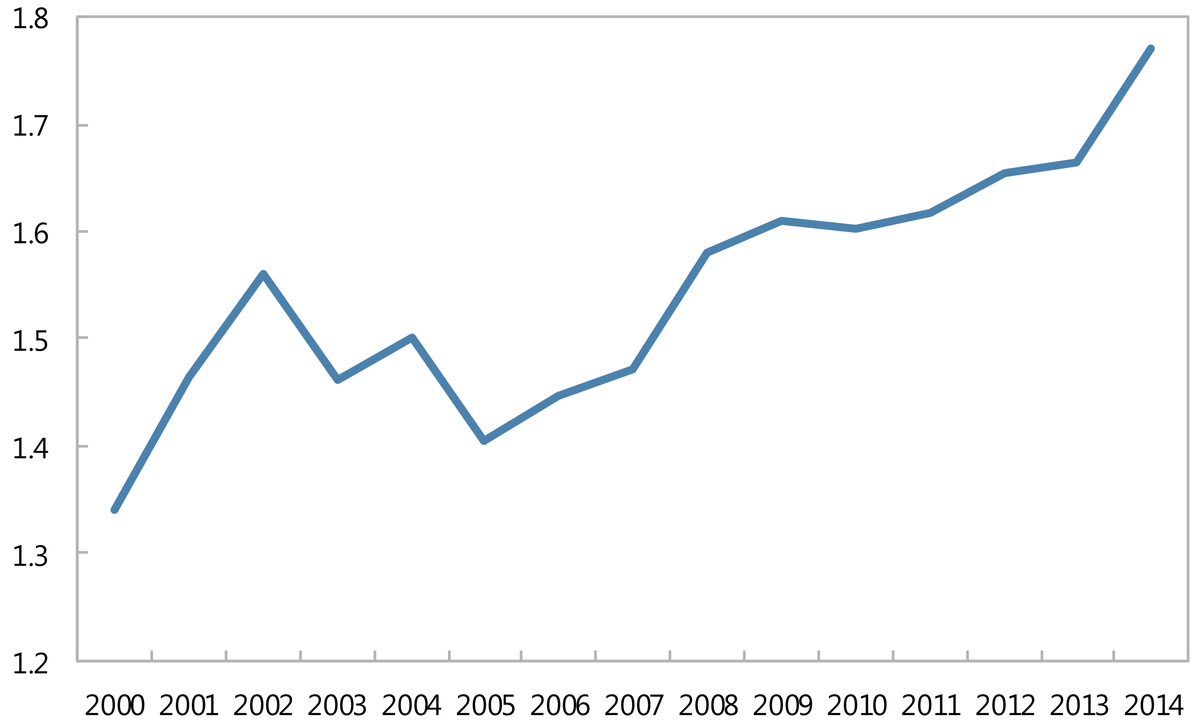
Estimated Drop in intangible asset investment rate after the financial crisis *(percentage points)*

Source: Duval, Timmer and Hong 2017, using Orbis data. Note: High/low rollover risk and high/low leverage correspond to the 75th and 25th percentiles of the cross-country cross-firm distribution of rollover risk and leverage, respectively, in the sample.

Crisis legacy No. 1. Balance sheet vulnerabilities

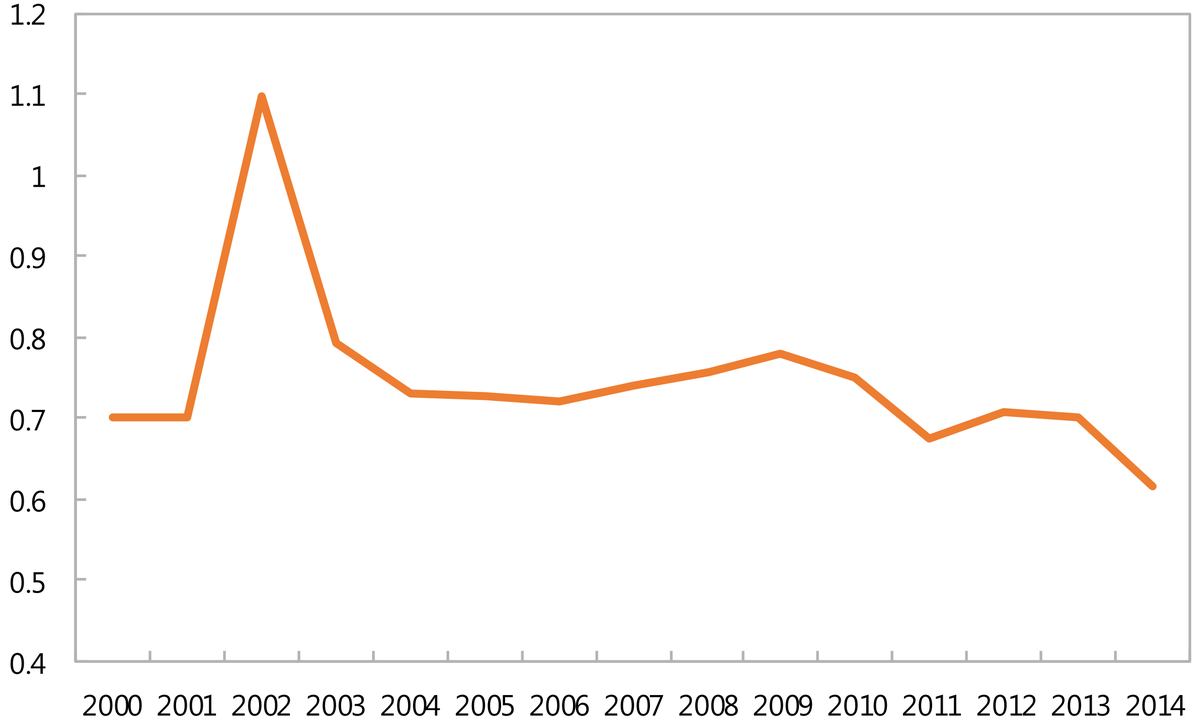
Misallocation of capital in AEs , 2000-14

(standard deviation of log marginal product of capital across firms, median country-sector)



Misallocation of labor in AEs , 2000-14

(standard deviation of log marginal product of labor across firms, median country-sector)

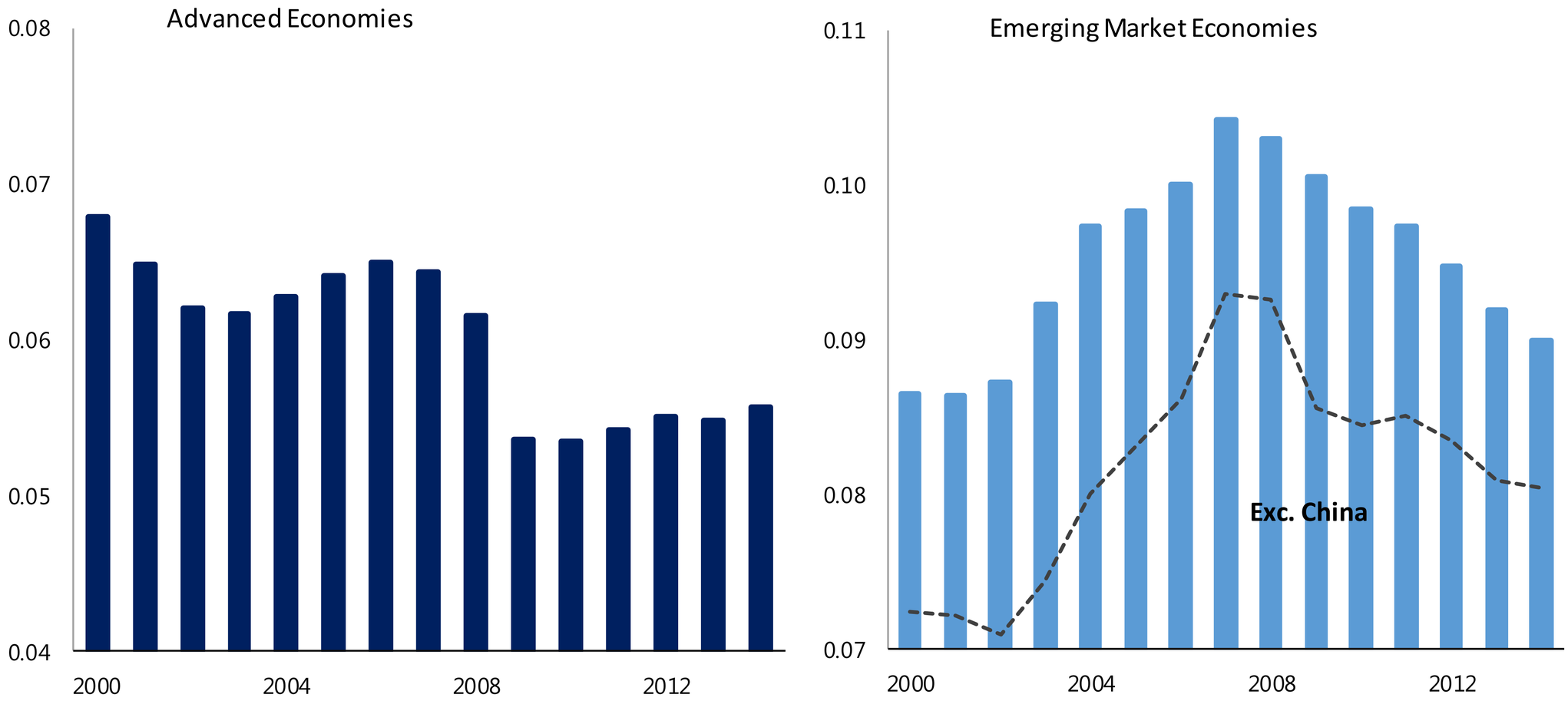


Sources: Orbis; and IMF staff calculations. Note: The calculation of standard deviations of log marginal products of capital and labor across firms in each country-industry follows the approach proposed by Hsieh and Klenow (2009).

Crisis legacy No. 2. Protracted weak demand and investment

Gross Fixed Capital Formation, 2000-14

(Share of stock of physical capital)



Sources: Penn World Table 9.0; IMF World Economic Outlook, and IMF staff calculations.

Weighted averages (using PPP-GDP as weights) are reported for each income group. For AE (EMEs), 20 (18) largest economies are reported.

Crisis legacy No. 2. Protracted weak demand and investment

Estimate impact of investment on TFP using PWT (112 countries, 1970-2014), in spirit of, but improving upon Wolff (AER 1991) on capital-embodied technol change:

$$\widehat{TPF_{i,p}} = \alpha + \beta_0 TFP_{i,p_0} + \beta_1 IK_{i,p} + \gamma_i + \delta_p + \varepsilon_{i,p}$$

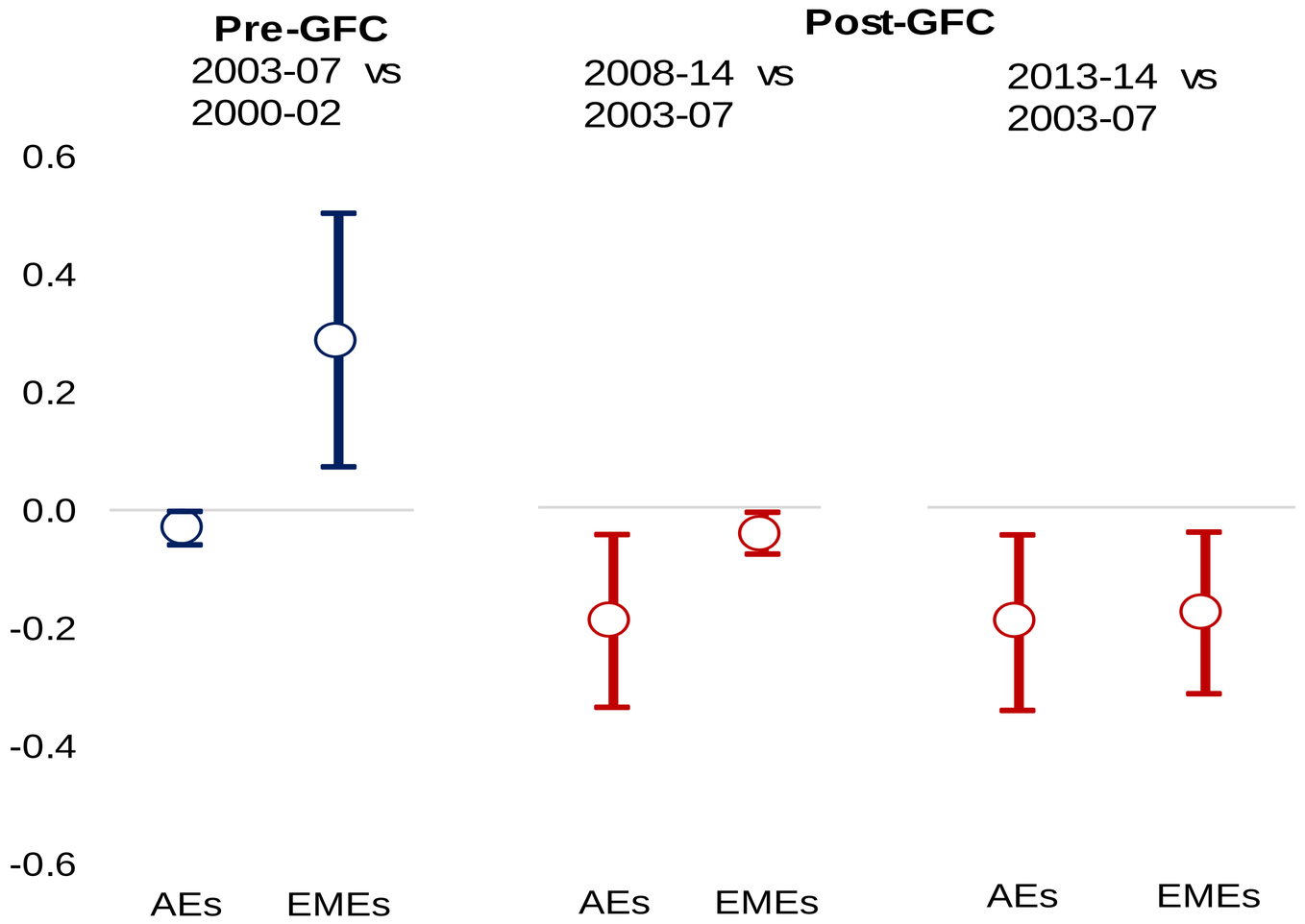
Where:

- $\widehat{TPF_{i,p}}$, $IK_{i,p}$ denote TFP growth and investment rate in country i in period p
- TFP_{i,p_0} is initial TFP gap relative to US in initial period (1970)
- γ_i and δ_p are country and period FEs (country characteristics that may affect innovation, e.g. institutions; common shocks, e.g. frontier innovations)
- Time periods: 1970-79, 1980-89, 1990-99, 2000-07, 2008-14

➔ Instrument $IK_{i,p}$ by $K_{i,0}/L_{i,0}$ and/or population growth (controlling for aging)

Crisis legacy No. 2. Protracted weak demand and investment

Estimated impact of change in investment rate on TFP growth around the GFC *(percent)*



Sources: PWT 9.0, WEO and IMF Staff estimates. PPP-GDP weighted average of 20 largest economies in each income group. Estimated contribution of capital accumulation to the change in TFP growth between stated periods. PPP-GDP weighted average by group. 90 percent confidence bands are reported.

Crisis legacy No. 3. Elevated economic and policy uncertainty

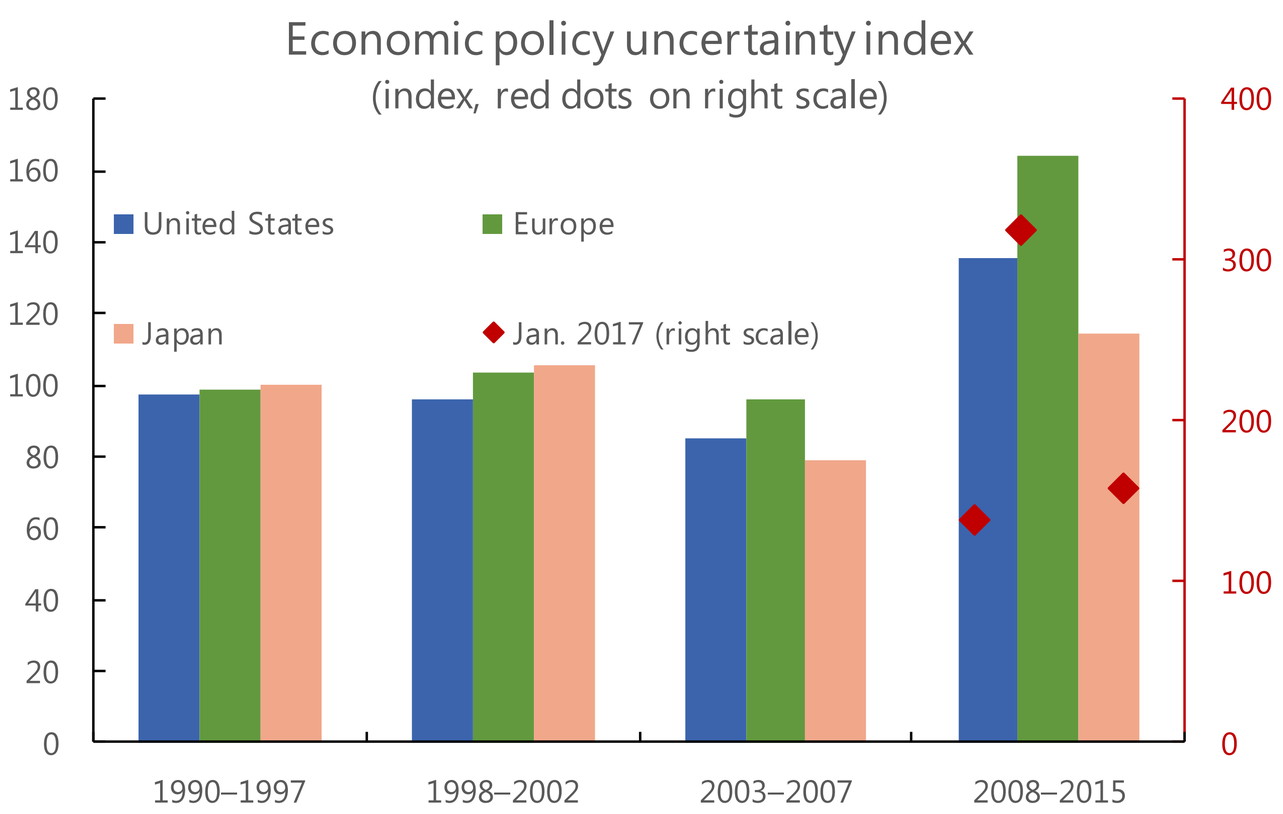
- Higher uncertainty can induce firms to adopt a “wait and see attitude” (Bloom et al., 2014) and tilt investment decisions toward more liquid, lower risk-return projects (Aghion et al., 2010)

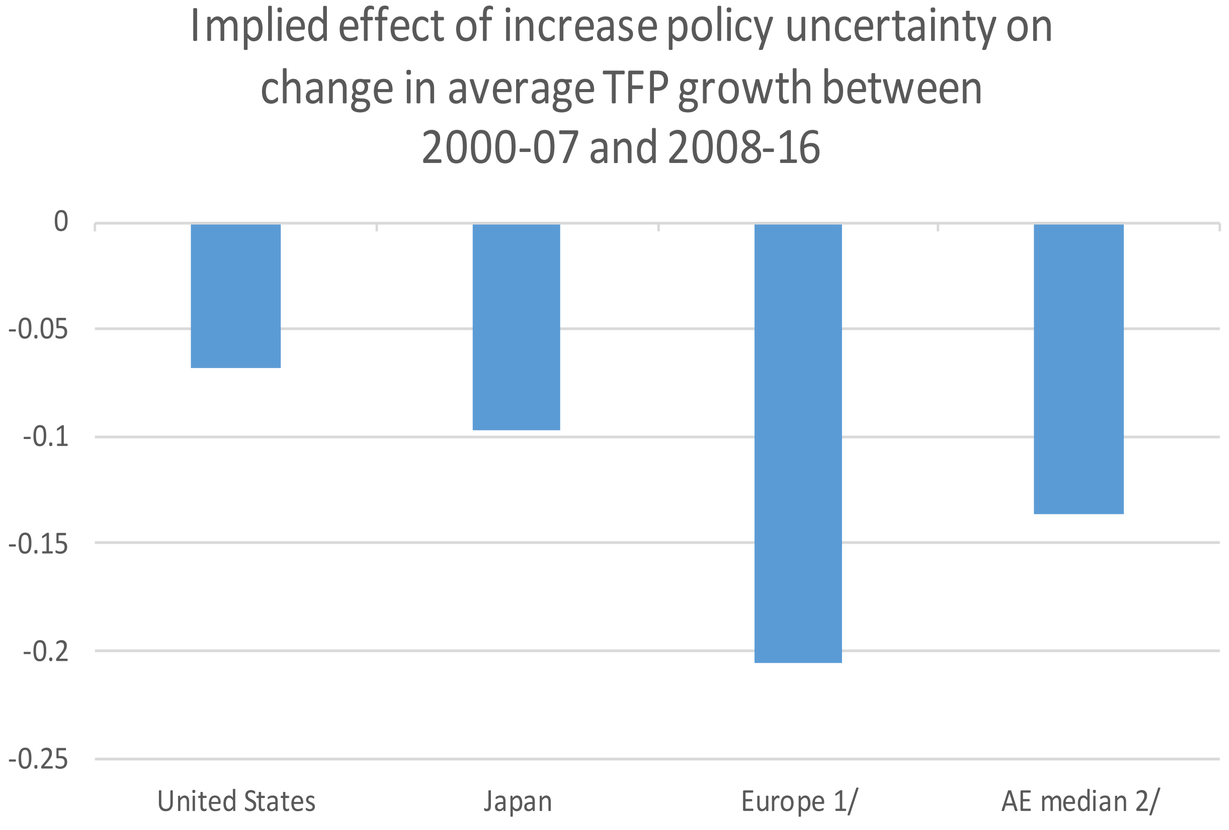
- Likely to be even more prevalent in industries that face tighter credit constraints (Choi, Furceri and Loungani 2016)

➔ Use this as identification strategy to estimate differential impact of economy-wide uncertainty on industry-level TFP depending on industry dependence on external finance (Rajan and Zingales 1998)

➔ Panel of 18 countries, 25 industries, 1985-2010 (EU and World KLEMS), controls for interactions between dependence on external finance and financial development, counter-cyclical fiscal policy…etc

Crisis legacy No. 3. Elevated economic and policy uncertainty





Sources: Baker, Bloom, and Davis (2016); EU KLEMS and WORLD KLEMS data; Organisation for Economic Co-operation and Development; and IMF staff estimations. Index for each country normalized to 100 mean. 1/ Includes France, Germany, Italy, Spain, and the United Kingdom. 2/ Ten advanced economies included in the sample: Canada, France, Germany, Italy, Japan, Korea, the Netherlands, Spain, the United Kingdom, and the United States.

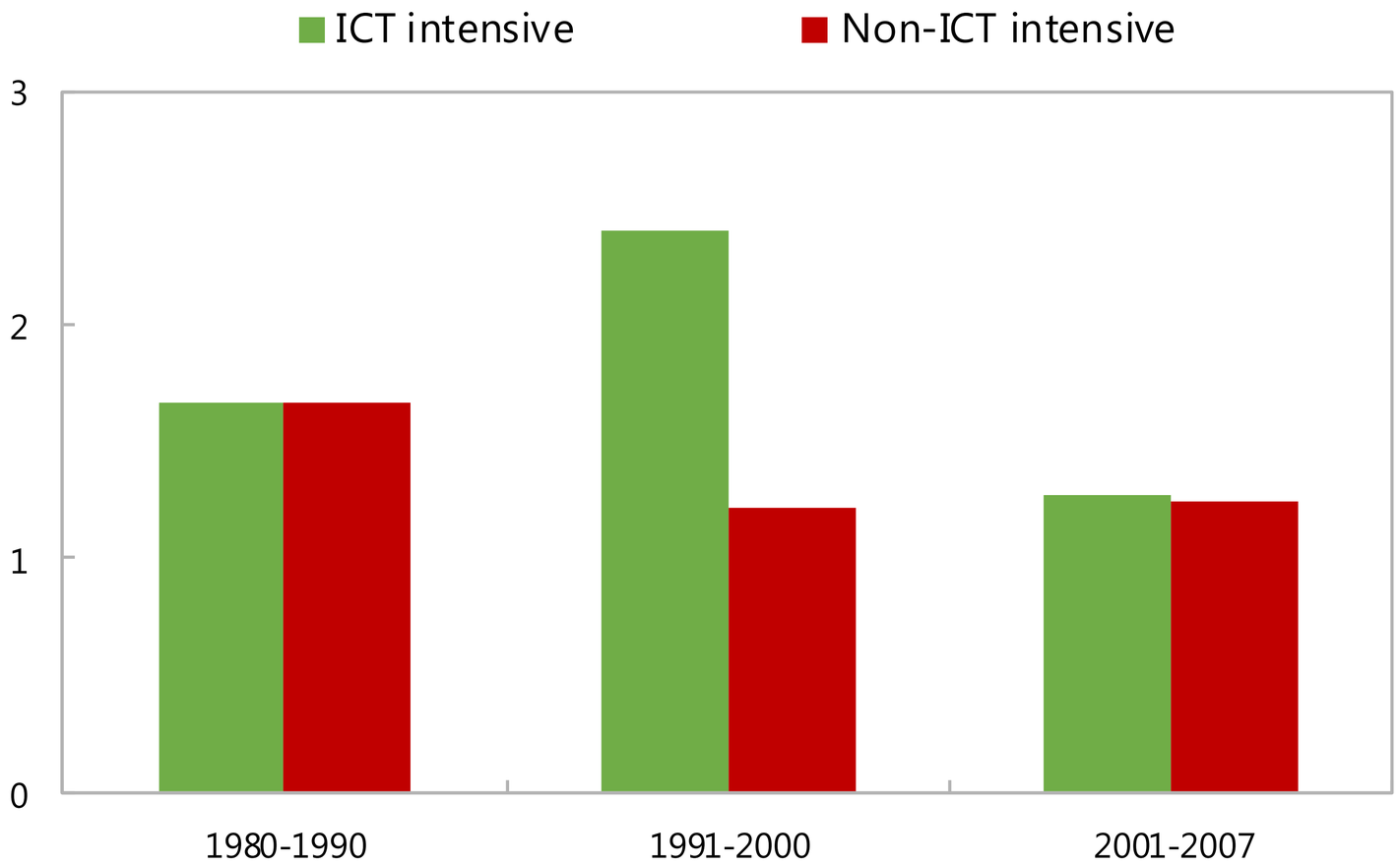
Some structural headwinds to innovation and diffusion

- Waning ICT boom and international spillovers
- Aging
- Slowdown in global trade integration
- Slowdown in human capital accumulation

Structural headwind 1: Waning ICT revolution, resulting in TFP slowdown at the (sector-level) frontier…

TFP growth at the sector-level frontier in ICT- and non-ICT-intensive sectors

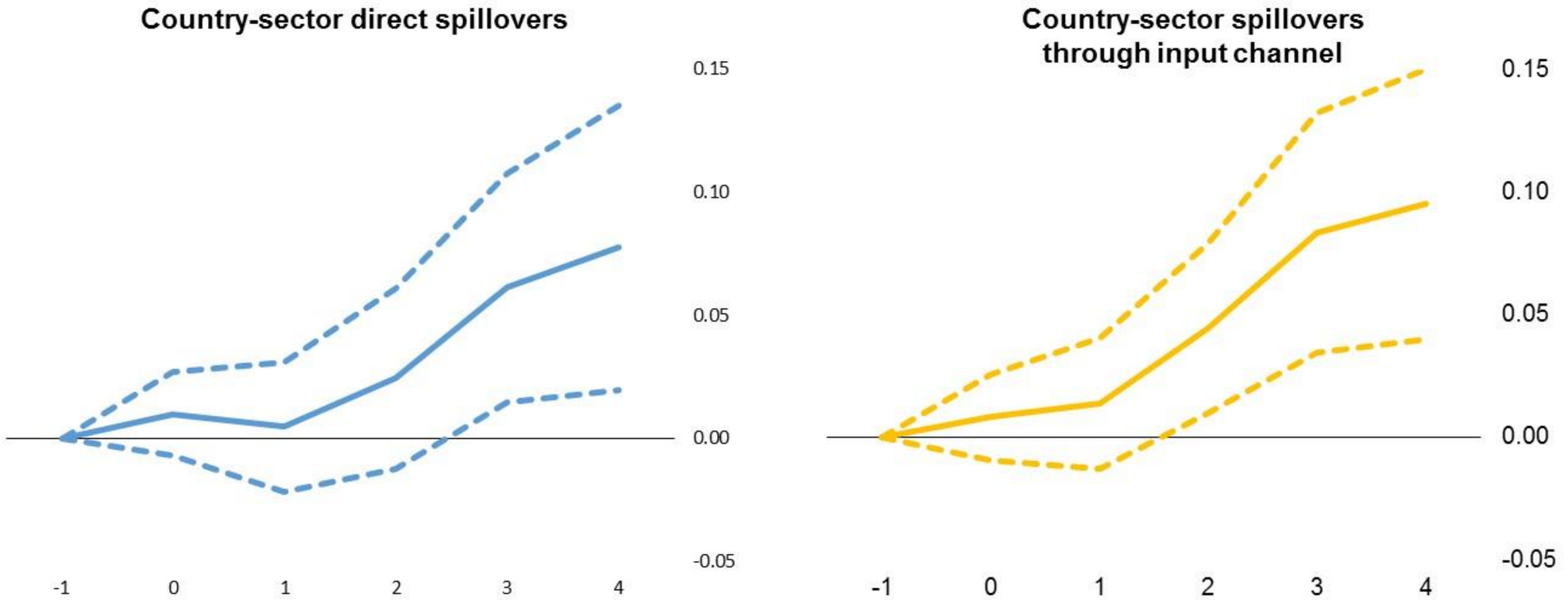
(advanced economies, percent)



Sources: EU KLEMS and WORLD KLEMS data; Dabla-Norris and others (2015); and IMF staff estimations. TFP frontier is defined as the average of the three highest TFP levels across countries, for each industry and year. For details, see Adler, Duval, Furceri, Koloskova and Poplawski-Ribeiro (2017).

Structural headwind 1: …and spillovers to lagging advanced economies

Spillovers from an 1 percent change in U.S. TFP growth to other AEs, 1970-2010
(percentage points; years on x-axis)



Sources: EU-KLEMS database; and IMF staff estimations.

Note: Estimates of the direct (industry-to-industry) relationship between shocks in the U.S. TFP growth and TFP growth at the country-industry level in other AEs for different horizons are obtained via local projections method. The input channel is estimated by interacting U.S. TFP growth shocks with a weighting matrix capturing the importance of each US industry as an input for a particular industry in each other AE. Estimations include country-sector- and year-fixed-effects and exclude top and bottom fifth percentiles of U.S. TFP growth sample distribution at industry level as outlier treatment. Dashed lines denote 90 percent confidence intervals.

Structural headwind 2: Aging

Estimate on sample of AEs and EMs over 1985-2014, building on Feyrer (ReStat 2007):

$$\Delta log(TFP)_{i,t} = \alpha_i + \gamma_t + \beta \Delta w55_{i,t-1} + \theta_k X_{i,t} + \varepsilon_{i,t}$$

Where:

- $\Delta log(TFP)_{i,t}$ is TFP growth rate in country i (Penn World Tables)
- $\Delta w55_{i,t-1}$ is the (lagged) change in share of 55-64 year-old workers in total employment
- $X_{i,t}$ is a set of controls including old- (65+) and young (0-14) dependency ratios, to control for other channels through which high dependency ratio can affect productivity (S rate, pressure on public transfers and taxes, structural transformation…)
- α_i, γ_t are country and time FEs

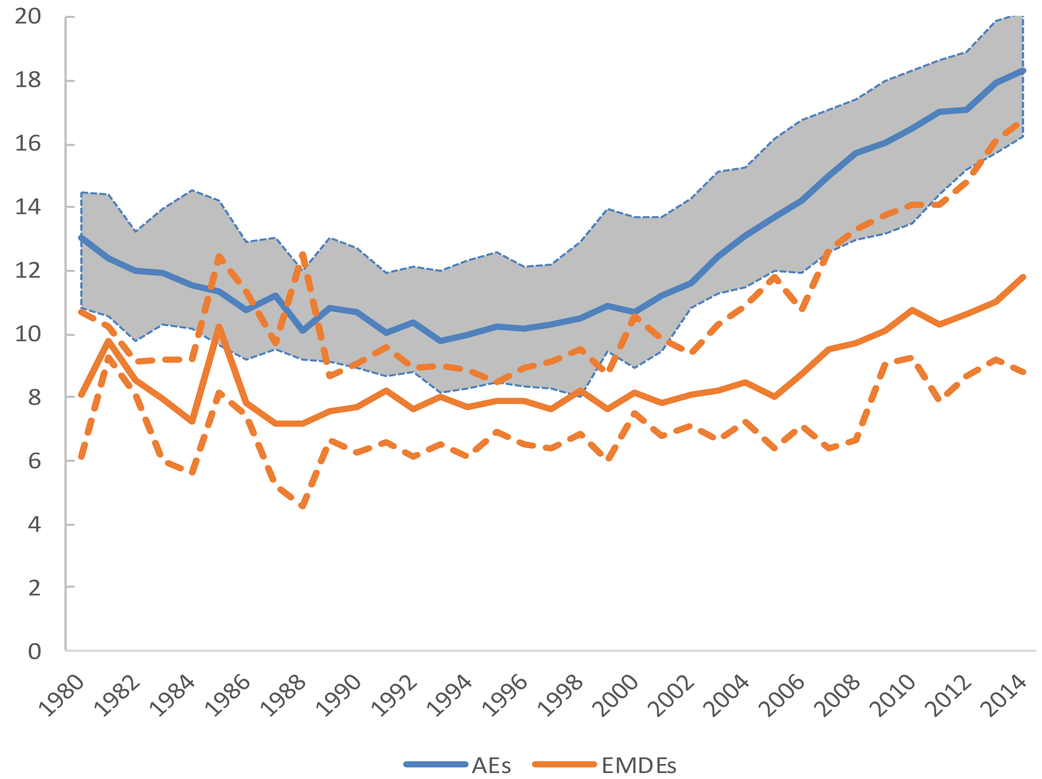
➔ Instrument $\Delta w55_{i,t-1}$ with 10-year lagged share of total population aged 45-54

➔ correlated with $\Delta w55_{i,t-1}$ but not with future technological innovations

Structural headwind 2: Aging

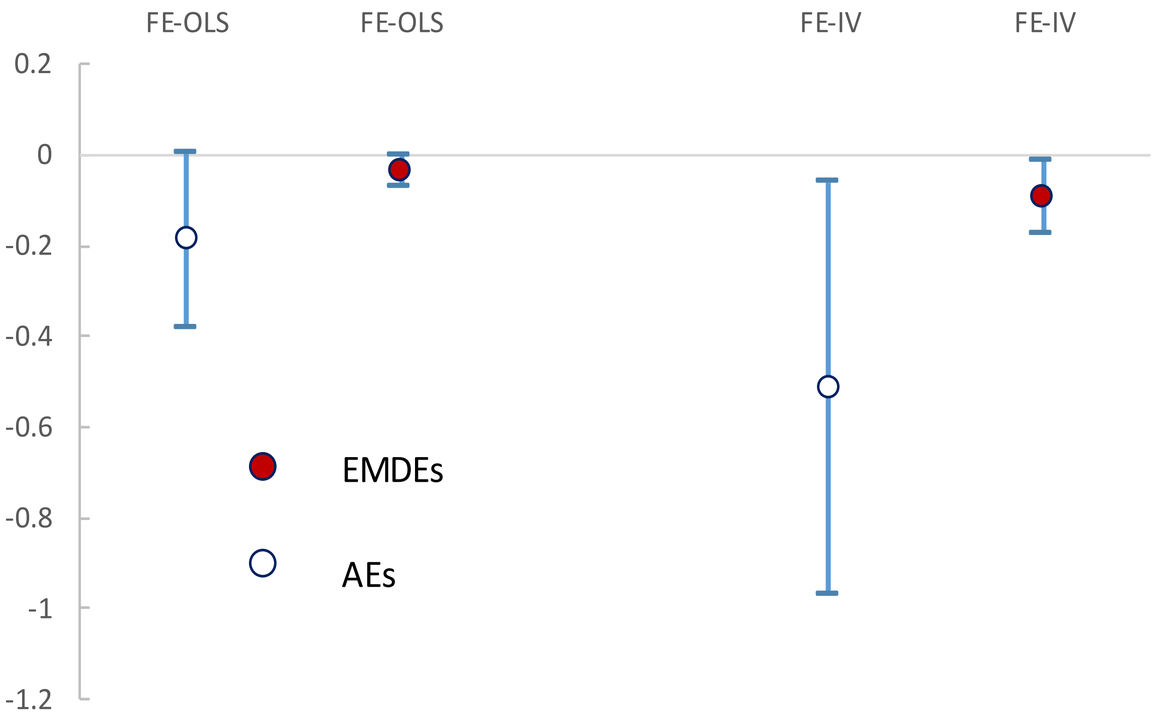
Share of older workers in total labor force

(share of 55-64 year-olds in total labor force, percent)



Estimated impact of aging on change in TFP growth between the 1990s and 2000s

(impact on annual TFP growth of change in share of 55-64 year-olds in total employment, average across countries)



Sources: ILO Labour Statistics; IMF Staff estimates. Left Panel: medians and interquartile ranges are reported. Right Panel: Vertical lines indicate 90 percent confidence intervals. Average effects for each group are based on observed changes in the share of old employed workers between the 1990s and the 2000s, and the estimated effects on TFP growth.

Structural headwind 3: Slowdown in global trade integration

- Post-GFC global trade slowdown owes primarily to weak demand, but also to supply-side factors, including waning liberalization efforts and maturing global supply chains (October 2016 IMF WEO Chapter 2)

- The supply-side part has slowed TFP growth in AEs through 3 well-documented channels in the literature: imports, imported inputs, exports

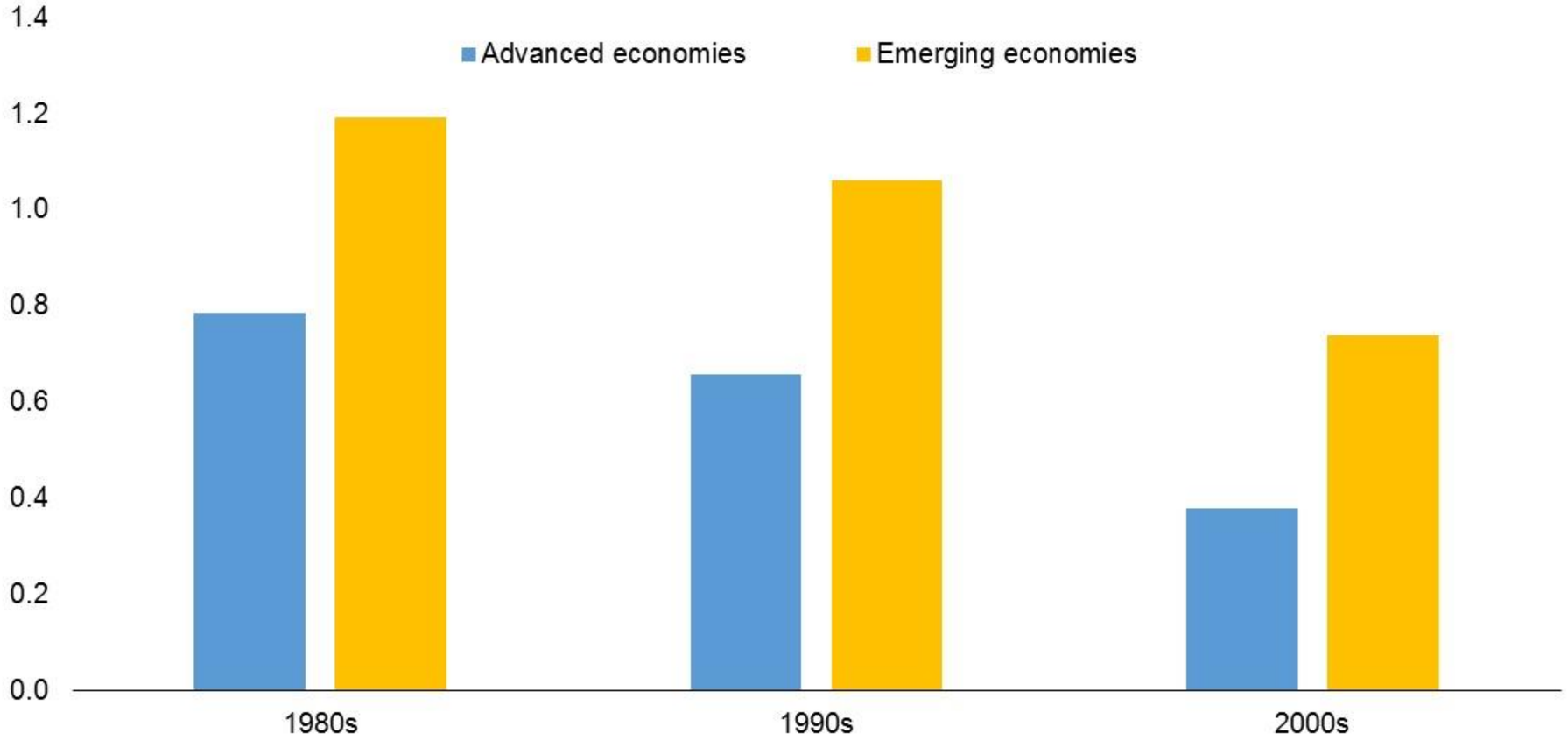
- We explore these channels for AE trade with China using KLEMS data and instruments inspired by Autor, Dorn and Hanson (AER 2013). See Ahn and Duval (2017) for details.

- We estimate that China's integration in world trade alone contributed 0.1 pct pts to annual TFP growth in median AE 2-digit industry over 1995-2007 ➔ Gain has been lost since GFC

Structural headwind 4: Slowdown in human capital accumulation

Contribution of human capital accumulation to annual labor productivity growth

(percent, simple average for both country income groups)



Sources: Murtin and Morrisson (2013), Organisation for Economic Cooperation and Development; and IMF Staff calculations.

Note: The calculation follows the approach of Hall and Jones (1999), only departing from them by allowing for diminishing rather than constant returns to schooling as estimated by Morrisson and Murtin (2013), and consistent with Psacharopoulos and Patrinos (2002).

Remedies to the productivity slowdown follow from its drivers

- **Immediate actions**: of highest priority in continental EU and JPN
  - Urgent measures to address weak bank and corporate balance sheets (EU)
  - Infrastructure spending (where there is need, fiscal space and/or slack)
  - Clarify course of fiscal, trade and regulatory policies to reduce uncertainty

- **Measures over the long haul**—mitigate structural headwinds through:
  - Higher spending on, and reforms of innovation policies and education systems
  - Renew structural reform efforts to enhance competition (product markets) and labor allocation (labor markets)
  - Advance open trade system and migration policies

➔ We quantify the productivity pay-off to some of these

Labor and product market reforms could lift TFP in a number of AEs

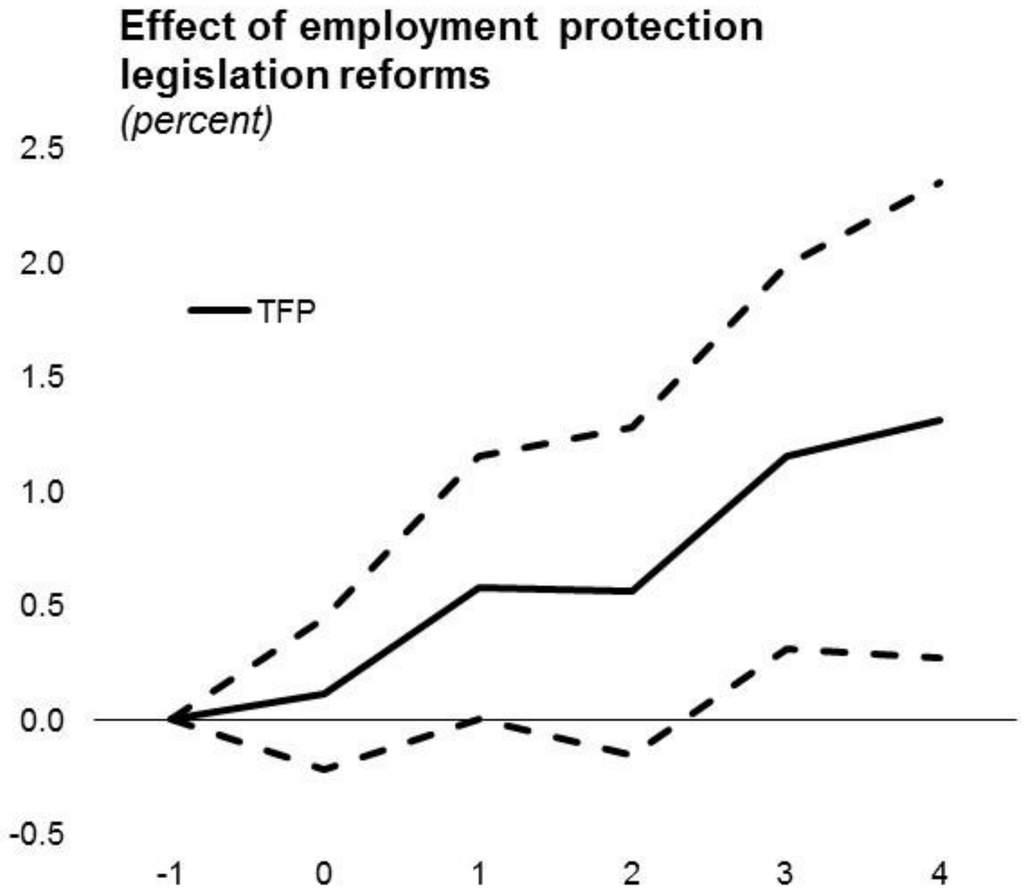
Estimate average response of cyclically-adjusted TFP to these major reform shocks (new "narrative" IMF database on major labor and product market reforms for 26 AEs over 1970-2013, see April 2016 IMF WEO Chapter 3):

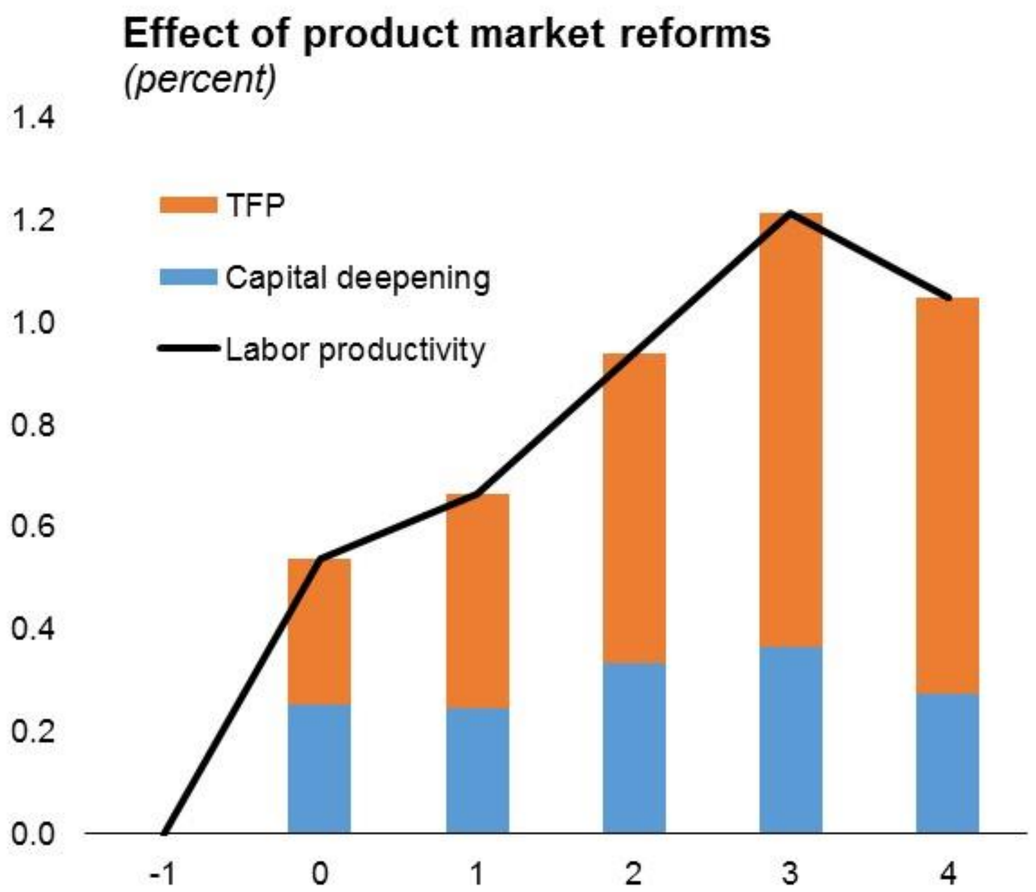
$$y_{i,t+k} - y_{i,t-1} = \alpha_i + \gamma_t + \beta_k R_{i,t} + \theta_k X_{i,t} + \varepsilon_{i,t}$$

Where:

- $y_{i,t+k} - y_{i,t-1}$ is the change in cyclically-adjusted TFP in country i between t-1 and t+k
- $R_{i,t}$ is the major reform shock considered (e.g. major liberalization of network industries, major easing of regular employment protection legislation)
- α_i, γ_t are country and time FEs
- $X_{i,t}$ is a set of controls including past growth, recession dummies, past reforms; expected growth (WEO forecasts) and reforms in other areas to address endogeneity

Labor and product market reforms could lift TFP in a number of AEs





Sources: Penn World Tables 9.0; Duval et al. (2016); and IMF staff calculations.

Note: Dashed lines denote 90 percent confidence bands. Capital deepening is defined as the difference between log labor productivity and log TFP. The effects are estimated using local projections method (Jorda (2005)), controlling for lagged growth, past reforms, and crisis dummies.

Take aways

- Productivity slowdown is partly structural:
  - Slowing innovation/diffusion, on account of several structural headwinds.
  - No scarcity of explanations—other researchers have highlighted other headwinds (e.g. product market structure, management, skill mismatches…).
  - More research needed to identify and discriminate between these factors.

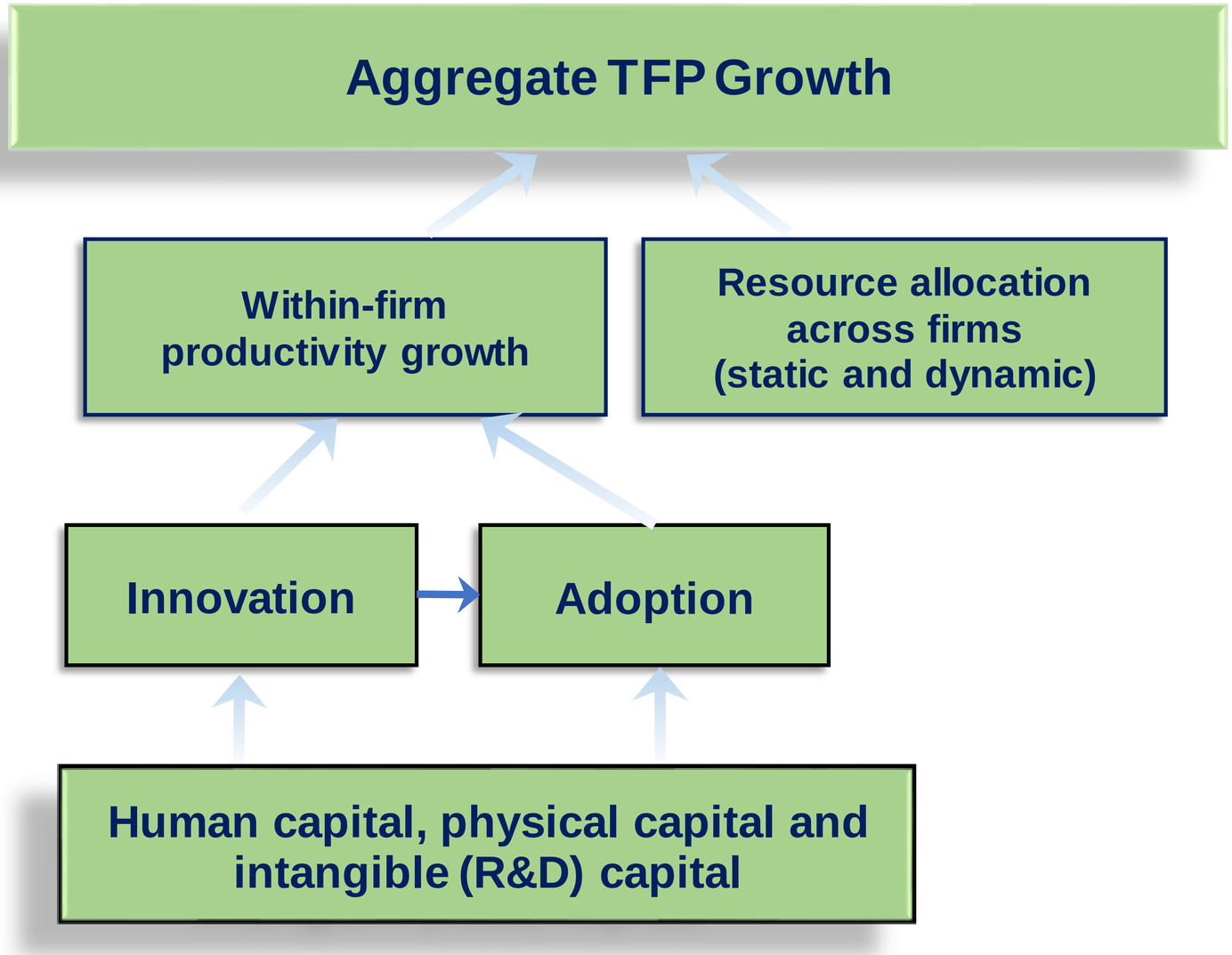
- But GFC itself has left scars—through lower and lower-risk/lower-return investment, plus capital misallocation—albeit to varying degrees (EU > US)

- Where is productivity growth headed?
  - Plausible scenario: TFP growth rises as crisis legacies dissipate, but does not return to pre-crisis rates as structural headwinds remain…
  - …unless/until artificial intelligence and other breakthroughs save us all!

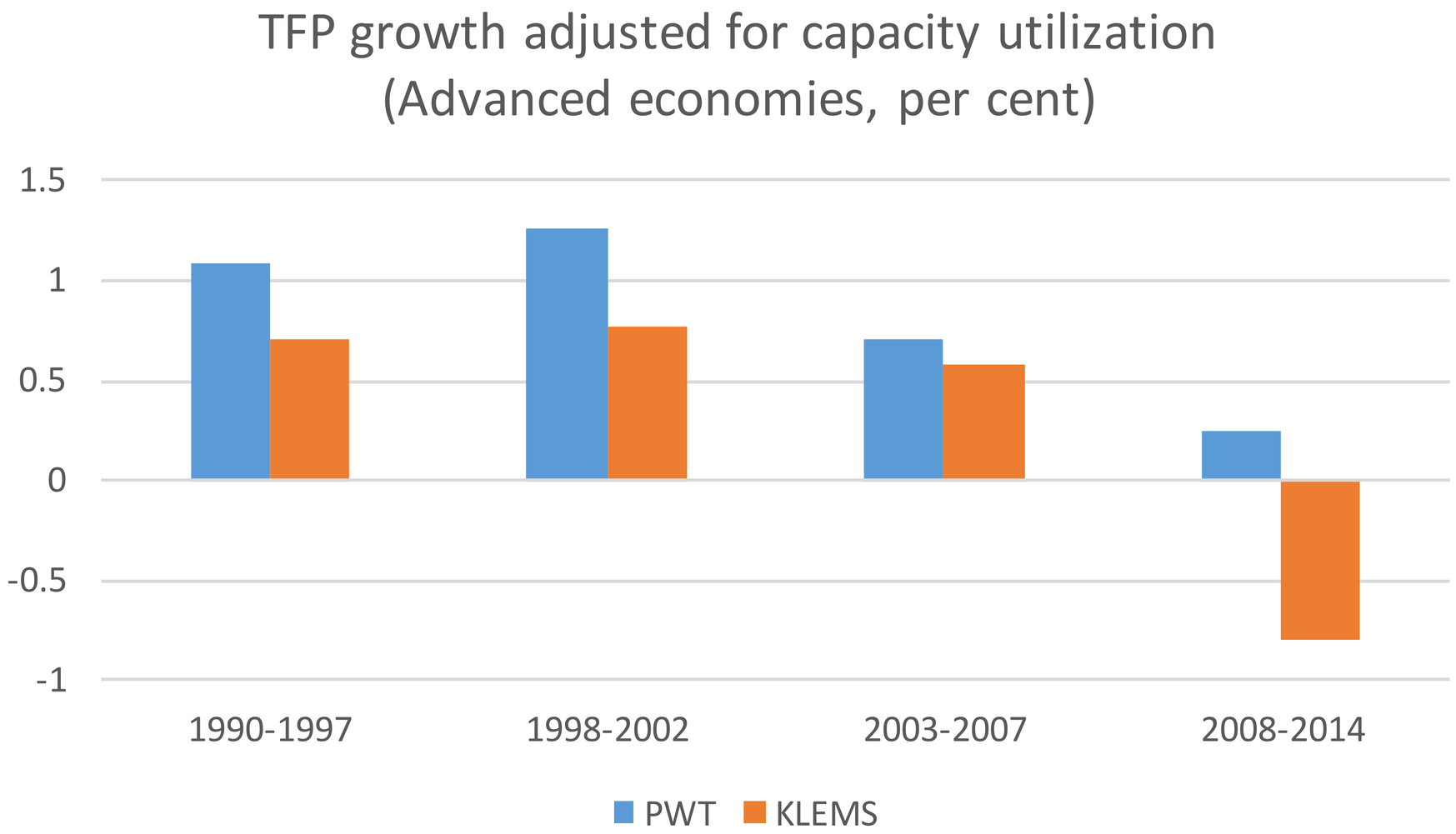
THANK YOU!!!

Extra slides

What drives total factor productivity growth?



The TFP slowdown has a clear structural component



Sources: PWT 9.0; World KLEMS; Furceri et al (2016); and IMF staff calculations. Note: PPP-GDP weighted average by group, based on WEO country classification. Cyclically-adjusted measure based on Basu, Fernald and Kimball (2006). Average hours worked used as a proxy for capacity utilization.